ESSENTIAL FISH HABITAT ASSESSMENT REPORT

for the Groundfish Resources of the

Bering Sea and Aleutian Islands Regions

Prepared by

National Marine Fisheries Service
Alaska Department of Fish & Game
North Pacific Fishery Management Council

Compiled by

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of Groundfish in the Bering Sea and Aleutian Islands

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Table of Contents

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INTRODUCTION

In 1996, the Sustainable Fisheries Act amended the Magnuson-Stevens Fishery Conservation and Management Act to require the description and identification of essential fish habitat (EFH) in fishery management plans (FMPs), adverse impacts on EFH, and actions to conserve and enhance EFH. Guidelines were recently developed by the National Marine Fisheries Service (NMFS) to assist Fishery Management Councils (Councils) in fulfilling the requirements set forth by the Act. In addition, the Act requires consultation between the Secretary and Federal and state agencies on activities that may adversely impact EFH for those species managed under the Act. It also requires the Federal action agency to respond to comments and recommendations made by the Secretary and Councils.

Essential fish habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat: "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

After reviewing the best available scientific information, and in cooperation with the Councils, participants in the fishery, interstate commissions, Federal agencies, state agencies, and other interested parties, NMFS will develop written recommendations for the identification of EFH for each FMP. Prior to submitting a written EFH identification recommendation to a Council for an FMP, the draft recommendation will be made available for public review and at least one public meeting will be held. NMFS will work with the affected Council(s) to conduct this review in association with scheduled public Council meetings whenever possible. The review may be conducted at a meeting of the Council committee responsible for habitat issues or as a part of a full Council meeting. After receiving public comment, NMFS will revise its draft recommendations, as appropriate, and forward written recommendation and comments to the Council(s).

The following is a summary of the EFH regulations set forth in the guidelines:

Habitat Requirements by Life History Stage

All FMPs must describe EFH in text and with tables that provide information on the biological requirements for each life history stage of the species. These tables should summarize all available information on environmental and habitat variables that control or limit distribution, abundance, reproduction, growth, survival, and productivity of the managed species. Information in the tables should be supported with citations.

Description and Identification of EFH

An initial inventory of available environmental and fisheries data sources relevant to the managed species should be useful in describing and identifying EFH. This inventory should also help to identify major species-specific habitat data gaps. Deficits in data availability (i.e., accessibility and application of the data) and in data quality (including considerations of scale and resolution; relevance; and potential biases in collection and interpretation) should be identified.

To identify EFH, basic information is needed on current and historic stock size, the geographic range of the managed species, the habitat requirements by life history stage, and the distribution and characteristics of those habitats. Information is also required on the temporal and spatial distribution of each major life history stage (defined by developmental and functional shifts). Since EFH should be identified for each major life history stage, data should be collected on, but not limited to, the distribution, density, growth, mortality, and production of each stage within all habitats occupied, or formerly occupied, by the species. These data should be obtained from the best available information, including peer-reviewed literature, data reports and "gray" literature, data files of government resource agencies, and any other sources of quality information.

The following approach should be used to gather and organize the data necessary for identifying EFH. Information from all levels should be used to identify EFH. The goal of this procedure is to include as many levels of analysis as possible within the constraints of the available data. Councils should strive to obtain data sufficient to describe habitat at the highest level of detail (i.e., Level 4).

> (1) Level 1: Presence/absence distribution data are available for some or all portions of the geographic range of the species. At this level, only presence/absence data are available to describe the distribution of a species (or life history stage) in relation to potential habitats. Care should be taken to ensure that all potential habitats have been sampled adequately. In the event that distribution data are available for only portions of the geographic area occupied by a particular life history stage of a species, EFH can be inferred on the basis of distributions among habitats where the species has been found and on information about its habitat requirements and behavior.
>
> (2) Level 2: Habitat-related densities of the species are available. At this level, quantitative data (i.e., density or relative abundance) are available for the habitats occupied by a species or life history stage. Because the efficiency of sampling methods is often affected by habitat characteristics, strict quality assurance criteria should be used to ensure that density estimates are comparable among methods and habitats. Density data should reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of habitat value. When assessing habitat value on the basis of fish densities in this manner, temporal changes in habitat availability and utilization should be considered.
>
> (3) Level 3: Growth, reproduction, or survival rates within habitats are available. At this level, data are available on habitat-related growth, reproduction, and/or survival by life history stage. The habitats contributing the most to productivity should be those that support the highest growth, reproduction, and survival of the species (or life history stage).
>
> (4) Level 4: Production rates by habitat are available. At this level, data are available that directly relate the production rates of a species or life history stage to habitat type, quantity, quality, and location. Essential habitats are those necessary to maintain fish production consistent with a sustainable fishery and the managed species' contribution to a healthy ecosystem.

The information obtained through the analysis of this section will allow Councils to assess the relative value of habitats. Councils should interpret this information in a risk-averse fashion, to ensure adequate areas are protected as EFH of managed species. Level 1 information, if available, should be used to identify the geographic range of the species. Level 2 through 4 information, if available, should be used to identify the habitats valued most highly within the geographic range of the species. If only Level 1 information is

available, presence/absence data should be evaluated (e.g., using a frequency of occurrence or other appropriate analysis) to identify those habitat areas most commonly used by the species. Areas so identified should be considered essential for the species. However, habitats of intermediate and low value may also be essential, depending on the health of the fish population and the ecosystem. Councils must demonstrate that the best scientific information available was used in the identification of EFH, consistent with national standard 2, but other data may also be used for the identification. If a species is overfished, and habitat loss or degradation may be contributing to the species being identified as overfished, all habitats currently used by the species should be considered essential in addition to certain historic habitats that are necessary to support rebuilding the fishery and for which restoration is technologically and economically feasible. Once the fishery is no longer considered overfished, the EFH identification should be reviewed, and the FMP amended, if appropriate. EFH will always be greater than or equal to aquatic areas that have been identified as "critical habitat" for any managed species listed as threatened or endangered under the Endangered Species Act. Where a stock of a species is considered to be healthy, then EFH for the species should be a subset of all existing habitat for the species.

Ecological relationships among species and between the species and their habitat require, where possible, that an ecosystem approach be used in determining the EFH of a managed species or species assemblage. The extent of the EFH should be based on the judgment of the Secretary and the appropriate Council(s) regarding the quantity and quality of habitat that is necessary to maintain a sustainable fishery and the managed species' contribution to a healthy ecosystem. If degraded or inaccessible aquatic habitat has contributed to the reduced yields of a species or assemblage, and in the judgment of the Secretary and the appropriate Council(s), the degraded conditions can be reversed through such actions as improved fish passage techniques (for fish blockages), improved water quality or quantity measures (removal of contaminants or increasing flows), and similar measures that are technologically and economically feasible, then EFH should include those habitats that would be essential to the species to obtain increased yields.

The general distribution and geographic limits of EFH for each life history stage should be presented in FMPs in the form of maps. Ultimately, these data should be incorporated into a geographic information system (GIS) to facilitate analysis and presentation. These maps may be presented as fixed in time and space, but they should encompass all appropriate temporal and spatial variability in the distribution of EFH. If the geographic boundaries of EFH change seasonally, annually, or decadally, these changing distributions need to be represented in the maps. Different types of EFH should be identified on maps along with areas used by different life history stages of the species. The type of information used to identify EFH should be included in map legends, and more detailed and informative maps should be produced as more complete information about population responses (e.g., growth, survival, or reproductive rates) to habitat characteristics becomes available. Where the present distribution or stock size of a species or life history stage is different from the historical distribution or stock size, then maps of historical habitat boundaries should be included in the FMP, if known. The EFH maps are a means to visually present the EFH described in the FMP. If the maps identifying EFH and the information in the description of EFH differ, the description is ultimately determinative of the limits of EFH.

Prey species

Loss of prey is an adverse effect on EFH and a managed species, because one component of EFH is that it be necessary for feeding. Therefore, actions that reduce the availability of a major prey species, either through direct harm or capture, or through adverse impacts to the prey species' habitat that are known to cause a reduction in the population of the prey species may be considered adverse effects on a managed species and its EFH. FMPs should identify the major prey species for the species in the FMU and generally describe the location of prey species' habitat. Actions that cause a reduction of the prey species population, including where there exists evidence that adverse effects to habitat of prey species is causing a decline in the availability of

the prey species, should also be described and identified. Adverse effects on prey species and their habitats may result from fishing and non-fishing activities.

Identification of habitat areas of particular concern

FMPs should identify habitat areas of particular concern within EFH. In determining whether a type, or area of EFH is a habitat area of particular concern, one or more of the following criteria must be met:

(i) The importance of the ecological function provided by the habitat.
(ii) The extent to which the habitat is sensitive to human-induced environmental degradation.
(iii) Whether, and to what extent, development activities are, or will be, stressing the habitat type.
(iv) The rarity of the habitat type.

SUMMARY OF TECHNICAL TEAM RECOMMENDATIONS

Members of the Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA) EFH Groundfish Technical Teams who compiled this report were Lowell Fritz (NMFS), David Witherell (NPFMC), David Ackley (ADF&G), Jeff Fujioka (NMFS), Sandra Lowe (NMFS), and Tory O'Connell (ADF&G). The report was compiled and reviewed on July 8-9 at a public meeting at the Alaska Fisheries Science Center. A summary of the Technical Teams comments are provided below.

As a first step in description and identification of EFH, summaries of available information on the habitat requirements and distributions of each life stage of managed groundfish species were prepared by the respective stock assessment scientists. In reviewing this information, the technical team noted differences between both the type and level of information available for most Alaskan groundfish compared with the expectations reflected in the national guidelines for description and identification of EFH. With respect to type, the information available for almost all species is primarily broad geographic distributions based on specific samples from surveys and fisheries which have not been linked with habitat characteristics. Furthermore, our ability to precisely define the habitat (and its location) of each life stage of each managed groundfish species in terms of its oceanographic (temperature, salinity, nutrient, current), trophic (presence of food, absence of predators), and physical (depth, substrate, latitude, and longitude) characteristics is very limited. Consequently, the information included in the habitat descriptions for each species and life stage is restricted primarily to their position in the water column (e.g., demersal, pelagic), broad biogeographic and bathymetric areas (e.g., 100-200 m zone, south of the Pribilof Islands and throughout the Aleutian Islands), and occasional references to known bottom types associations.

Specification of EFH Information Levels

With respect to the level of information available to describe species' habitats, the technical team defined level 0 as a subset of the level 1 defined in the proposed rule. Level 0 was necessary to distinguish situations where no systematic sampling had been conducted for a species and life stage, but which may have been caught opportunistically during a survey using appropriate gear.

Classification of EFH levels used in this document based on available information. Note that this classification system differs slightly from the NMFS guidelines.

Level 0	No systematic sampling has been conducted for this species and life stage; may have been caught opportunistically in small numbers during other surveys.
Level 1	Presence/absence distribution data are available for some or all portions of the geographic range.
Level 2	Habitat-related densities are available. Density data should reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of habitat value.
Level 3	Habitat-related growth, reproduction, or survival rates are available. The habitats contributing the most to productivity should be those that support the highest growth, reproduction, and survival of the species (or life history stage).
Level 4	Habitat-related production rates are available. Essential habitats are those necessary to maintain fish production consistent with a sustainable fishery and a healthy ecosystem.

The technical team discussed how information levels could be applied to defining EFH. In cases where only level 0 information is available (e.g., for almost all egg and larval stages of North Pacific groundfish species), the technical team recommends that EFH be defined as everywhere the species' life stage has been observed, plus all of those areas of similar habitat based on literature-reported ranges and the opinions of scientists and persons with local knowledge. This EFH recommendation also applies to species/stages with level 1 information. In cases where level 2 information is available, the team recognized that areas of known concentration could be identified within a reported general distribution. Although areas of high concentration will be noted, EFH would still be designated as the general distribution, as with levels 0 and 1, as sufficient information could not be found (does not exist) "to determine

the necessary habitat to support the target production goal." This was concluded because of the arbitrary nature of the cutoff between high and low concentrations of the species, the resolution mismatch between habitat descriptions and species' distributions discussed above, and the team's inability to distinguish between areas occupied by a species and those habitats "necessary for spawning, breeding, feeding or growth to maturity" for an appropriate and useful EFH designation. This EFH designation follows that allowed under the NMFS guidelines.

The primary distinction between level 1 and 2 data is based on how well the available surveys sample a certain species life history stage. In this report level 1 will refer to the situation where systematic sampling is adequate to reasonably establish presence or absence and encompasses a significant portion of potential habitat. Where sampling is inadequate to establish absence, and presence is established opportunistically or by studies in only a limited portion of the probable range, a level 0 is designated. For the most part, the only source of information that results in an information level of 1 or 2 are the AFSC surveys for stock assessment of adults. As a baseline, the team considered the bottom trawl survey did the best job of sampling adult shallow water flatfish in the Bering Sea. In this case, the sampling gear was relatively efficient at capturing this species, and sampling covered the entire adult distribution. So for adult rock sole, areas of high density could be identified at level 2 information. On the other hand, the bottom trawl and longline surveys were unable to provide level 2 information for adults of a species that ranged deeper than the survey area (e.g., thornyheads), or occurred in areas not thoroughly surveyed (e.g., Atka mackerel). A summary of the technical team's information classification for groundfish species is shown in the adjacent table. Closer examination of trawl survey data during the next phase of EFH identification may allow attainment of a higher level for certain shelf species groups (e.g., sculpins, skates).

Levels of essential fish habitat information currently available for BSAI groundfish, by life history stage. Juveniles were subdivided into early and late juvenile stages based on survey selectivity curves.

Species	Eggs	Larvae	Early Juveniles	Late Juveniles	Adults
Pollock	1	1	1	1	2
Pacific cod	0	0	0	1	2
Yellowfin sole	0	0	0	1	2
Greenland turbot	0	0	0	1	2
Arrowtooth flounder	0	0	0	1	2
Rock sole	0	0	0	1	2
Other flatfish	0	0	0	1	2
Flathead sole	0	0	0	1	2
Sablefish	0	0	0	1	2
Pacific ocean perch	-	0	0	0	1
Northern rockfish	-	0	0	1	1
Shortraker rockfish	0	0	0	0	1
Rougheye rockfish	0	0	0	1	1
Thornyhead rockfish	0	0	0	0	1
Atka mackerel	0	0	0	0	2
Squid	0	0	0	0	0
Other species					
sculpins	0	0	0	0	1
skates	0	0	0	0	1
sharks	-	0	0	0	0
octopus	0	0	0	0	0
Forage fish species					
smelts	0	0	0	0	0
other forage fish [1]	0	0	0	0	0

NOTE: "-" indicates a species that has internal fertilization and bears live young.
[1]Other forage fish includes all members of the lanternfish, deep sea smelt, sand lance, sandfish, gunnel, shanny, krill, bristlemouth families.

Egg and Larval Stages

Egg and larval stages for all species, except pollock in the Gulf of Alaska, were classified as knowledge level 0. While collections of eggs and larvae of many other species occur (Kendall and Dunn, 1985), as well as studies limited in area coverage, such as for Pacific cod (Rugen and Matarese, 1988), sablefish (Wing 1997,

Kendall and Matarese 1984), no systematic surveys for other species occurs. Existing maps of egg and larval distributions would be based on extrapolations from collections, or inferred from the presence of spawning adults, current drift, not from specific mapping of sampling programs. The team considered these situations as level 0. The NOAA Atlas does specify known spawning grounds Pacific cod, which has demersal eggs, in the Bering Sea, southwest and northeast of Kodiak and near Sanak and Shumagin Islands, based on prevalence of spawning stage fish. The team still designated a level 0 for Pacific cod egg stage as it was unaware of information substantiating absence specifically for eggs from other parts of the probable range and did not assume spawning stage fish distribution described egg distribution.

Juvenile Stages

The early juvenile stage of all species, except pollock were classified at level 0. Similar to eggs and larvae stages, there are no extensive coverages of probable habitat of early juvenile fish. There are collections and observations documenting presence in specific locations, and some studies (Carlson and Straty 1981, Norcross 1996) in specific locations, as well as some surveys with limited area coverage (ADFG shellfish, RACE Kodiak juvenile trawl). Where early juveniles are found in surveys, it is unlikely their major distribution has been encompassed and considerable potential habitat lies outside the survey area. There are significant amounts of potential nearshore habitats for juvenile fish that are not adequately sampled to determine presence or absence.

For many species, few immature fish show up in the Center's assessment surveys, and little is known about their distribution for the entire juvenile stage. Some species, however, are taken in the trawl surveys and fisheries during their late juvenile, or subadult stage, to the extent that the survey area appears to encompass a significant portion of their habitat. For these species, information for the late juvenile or subadult stage was considered to be at a level 1. Based on estimated size of maturity, immature yellowfin sole, and the shallow water flatfish complex in the Gulf, are taken over an extensive area by the trawl surveys. Likewise, major concentrations of immature Pacific cod are encompassed by trawl survey coverage in the Bering Sea and Central Gulf of Alaska. Strong year classes of sablefish occur in the late juvenile stage (3-4 years old) along the shelf in the GOA and Bering Sea trawl surveys. Northern and rougheye rockfish less than the size of 50% maturity (36 cm for female northerns,44 cm for rougheye) are commonly taken in the trawl survey, generally in shallower habitat than mature fish. Shortraker rockfish of comparable size are notably rare in the survey.

Adults

The adult stage for most key groundfish species are present in the Center's groundfish surveys. The trawl survey coverage for Pacific cod, shallow water flatfish, such as yellowfin sole, and flathead sole is considered at a level 2. The coverage from the combined trawl survey and hydroacoustic surveys for pollock is considered a level 2. Coverage is not complete for species such as deepwater flatfish, rockfish, thornyheads, and Atka mackerel which are considered at level 1. The trawl survey does not cover the rough bottom areas which are prevalent in the range of many slope rockfish, demersal shelf rockfish, and Atka mackerel. Other than dusky rockfish, pelagic rockfish are seldom taken in the bottom trawl survey, either because they are off bottom or reside over rocky untrawlable habitat. While thornyhead rockfish are taken consistently in the longline survey, they mature at a very small size and many mature thornyheads would be too small to be taken on the gear.

The technical team agreed that information about the entire range of a species should be included in the text descriptions, but the maps should only show the EFH distributions and known areas of high concentrations within United States (3-200 nautical miles) and State of Alaska (0-3 miles) waters.

Identification of EFH for some species included historical range information. Traditional knowledge and sampling data have indicated that fish distributions may contract and expand due to a variety of factors

including, but not limited to, temperature changes, current patterns, changes in population size, and changes in predator and prey distribution.

The technical team has some suggestions for future GIS mapping of fish distributions. Maps should include the date prepared, the information or data sets used, and location of sampling stations.

A primary source of many of the maps featured in this document was the NOS publication, Coastal and Ocean Zones Strategic Assessment: Data Atlases of the West Coast of North America and of the Bering, Chukchi, and Beaufort Seas (1988, 1990). These maps provide excellent coverage of fish and larval distributions. However, since the source data for especially spawning and larval distributions is unknown and possibly conjectural, inaccuracies in the data may be present. It should be kept in mind that the distributions shown here are a first-cut and that distributions should be verified and updated as better or more current data become available. GIS coverages based on NMFS survey and catch information will help provide the necessary verification and update of the NOS data. Larval and egg distributions will require research surveys specifically designed to collect this information. Other useful sources were:

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and northeastern Pacific. U.S. Dep. Commer., NOAA Tech. Rept. NMFS 66, 151 p.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-84. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

The technical team also discussed research needs to describe and identify EFH based on their review of available information. Initial research should focus on identification, quantification and mapping of habitats on the shelf and slope. The team notes requests for bathymetric mapping of the sea bottom to improve stock assessment capability in the Alaska EEZ have been a low priority for NOS. The team recommends increased support of the modest AFSC effort to develop bottom typing capability. The nearshore area in particular has been under-surveyed resulting in a lack of information on habitat utilization and densities for species including Atka mackerel, Pacific cod, pelagic rockfishes, octopus and flatfishes, juveniles of sablefish, pollock, halibut and flatfish. The team notes the extent of level 0 and 1 tiers in the EFH level table. To increase EFH tier levels and obtain valid measures of habitat utilization, systematic surveys must be conducted throughout the full-depth habitat range of each species.

Abbreviations used in the EFH report tables to specify location, depth, bottom type, and other oceanographic features.

Location

BCH = beach (intertidal)
ICS = inner continental shelf (1-50 m)
MCS = middle continental shelf (50-100 m)
OCS = outer continental shelf (100-200 m)
USP = upper slope (200-1000 m)
LSP = lower slope (1000-3000 m)
BSN = basin (>3000 m)
BAY = nearshore bays, give depth if appropriate (e.g., fjords)
IP = island passes (areas of high current), give depth if appropriate

Water column

D = demersal (found on bottom)
SD/SP =semi-demersal or semi-pelagic if slightly greater or less than 50% on or off bottom
P = pelagic (found off bottom, not necessarily associated with a particular bottom type)
N = neustonic (found near surface)

Bottom Type

M = mud S = sand R = rock
SM = sandy mud CB = cobble C = coral
MS = muddy sand G = gravel K = kelp
SAV = subaquatic vegetation (e.g., eelgrass, not kelp)

Oceanographic Features

UP = upwelling G = gyres F = fronts
CL = thermo- or pycnocline E = edges

General

U = Unknown NA = not applicable

Public attendance at the technical team meeting and other staff included Cindy Hartmann, Linda Roberts, Shirley White, Loh-lee Low, Dan Waldeck, Cyreis Schmitt, Clarence Pautzke, David Fluharty, and Brent Paine.

Summary of Ongoing Surveys

Sablefish Longline Survey

Since 1978, the National Marine Fisheries Service (NMFS) and Alaska Fisheries Science Center (AFSC) has conducted annual longline surveys of sablefish and other commercially important groundfish species, both cooperatively (Japan - U.S. cooperative longline survey, 1978-94) and alone (domestic longline survey, 1987-present). The survey is conducted jointly by two components of the AFSC: the Auke Bay Laboratory and the Resource Assessment and Conservation Engineering (RACE) Division. Data gathered on this annual survey has been used to manage the sablefish fishery for several years and has also provided information on other fish species to the North Pacific Fishery Management Council (NPFMC).

Primary objective of the survey is to determine the abundance and size composition of sablefish (*Anoplopoma fimbria)* and other commercially important longline-caught species along the upper continental slope of Alaska: i.e., shortspine thornyhead (*Sebastolobus alascanus),* shortraker and rougheye rockfish (*Sebastes borealis* and *aleutianus),* and Greenland turbot (*Reinharditius hippoglossoides)*. Other groundfish species caught during the survey include: Pacific cod (*Gadus macrocephalus),* Pacific halibut (*Hippoglossus stenolepis*), arrowtooth flounder (*Atheresthes stomias*), and grenadiers (*Macrouridae*). However, the survey covers only a partial range of the depth habitat of these species. The survey also tags sablefish, Greenland turbot, and shortspine thornyheads.

The survey area has covered the upper continental slope of the Gulf of Alaska (1978-present) from Dixon Entrance to Umnak Island, the eastern Bering Sea (1982-94) and the eastern Aleutian Islands (1980-94, 1996), and selected gullies (1987-present) of the Gulf of Alaska (GOA). The AFSC survey will sample the Aleutian Islands region and the eastern Bering Sea in alternate years. Stations are approximately 20 nm apart along the slope, and are sampled with 16 km of longline, containing 7,200 hooks. Gear is set from shallow to deep starting near the edge of the slope, down to a depth of 1,000 meters.

RECOMMENDATIONS FOR IDENTIFICATION AND DESCRIPTION OF ESSENTIAL FISH HABITAT

for the Groundfish Resources
of the Gulf of Alaska,
Bering Sea, and Aleutian Islands Regions

by
The Technical Team for Essential Fish Habitat
for the Groundfish Resources of the Alaska Region

Background

Summaries and assessments of habitat information for Gulf of Alaska and Bering Sea and Aleutian Islands Region Groundfish species are provided in Essential Fish Habitat Assessment Reports (NPFMC 1997a;b). The Team reviewed habitat descriptions and life history information summarized by fishery stock assessment scientists and determined the levels of information available for each life stage of major species in the FMP of the BSAI and GOA FMPs. The information contained in these summaries along with that contained in data atlases (NOAA 1987; 1990), summaries of fishery and survey data (Allen and Smith 1988; Wolotira et al. 1993; Fritz et al. In press a;b), and fish identification books (Hart 1973; Eschmeyer and Herald 1983) were used to determine the level of knowledge available to identify EFH for each life stage of each major groundfish species. In evaluating the level of knowledge available, the Technical Team defined a level 0 as a subset of level 1 as defined by NMFS in the guidelines for determining the level of information on the distribution of a life stage. For life stages of BSAI and GOA groundfish, the Team determined that information of level 0, 1, and 2 was available.

From this information, ***general distributions*** of species life stages were defined. A general distribution of a species' life stage is a subset of its current and historic range, and is the geographic area containing most (approximately 95%) of the individuals across all seasons. Habitats occupied by the species' life stage are located within each general distribution. Rare observations that extend a species range during anomalous environmental conditions would not be considered part of its general distribution.

For life stages with information levels 1 and 2, *general distributions* were determined geographically as the area encompassing at least 95 percent of positive survey samples in Fritz et al. (In press, a;b) and supplemented as necessary by distribution information available in NOAA (1987;1990), Wolotira et al. (1993), and Allen and Smith (1988) to allow for survey coverage limitations, and by any relevant knowledge of life history or habitat associations. Maps illustrating general distributions for species life stages for which level 1 or 2 is available are provided.

For life stages with level 0 information, *general distributions* were inferred from where a species has been observed and any relevant knowledge of its life history and habitat associations. No maps for life stages with level 0 information were drawn.

Areas of ***known concentrations*** within a general distribution were also defined as the approximate area encompassing survey or fishery hauls with density (catch per unit effort) observations in the upper 66th percentile of positive observations of a species life stage in Fritz et al. (In press a;b), and supplemented as necessary by distribution information available in NOAA (1987;1990), Wolotira et al. (1993), and Allen and Smith (1988) to allow for survey coverage limitations, and by any relevant knowledge of life history or habitat associations. *Known concentrations* are defined only for species life stages for which level 2 knowledge is available (only for the adult stages of certain groundfish) and are shown on the accompanying maps.

Recommendations for Identification and Description of Groundfish EFH

The Groundfish Technical Team considered the alternatives of using general distribution or known concentrations to define EFH for species' life stages for which level 2 information was available. The Team's principal concern was that using known concentrations alone to designate EFH would not ensure that adequate areas were protected as EFH. Specific reasons discussed by the Team in support of this conclusion were:

1. Areas of known concentrations based on current information do not adequately address unpredictable annual differences in spatial distributions of a life stage, nor changes due to long term shifts in oceanographic regimes.

   Annual differences in distribution of high concentrations of adults, particularly for pelagic or semi-demersal species (e.g., pollock, Pacific cod) occur and are unpredictable. Within the last 20 years, from which most data has been obtained, long term changes in concentrations have been observed in Alaska groundfish. The spawning distribution of Gulf of Alaska pollock has changed dramatically since the 1970s. Relative distribution of the Alaska sablefish stock between the BS, AI, and GOA has cycled since the late 1970s.

2. All habitats occupied by a species contribute to production at some level. Although contributions from individual locations may be small, collectively they can account for a significant part of total production.

3. A stock's long term productivity is based on both high and low levels of abundance and the entire general distribution may be required during times of high abundance

4. There is a seasonal limitation on survey information (chiefly summer) upon which descriptions of known concentrations are primarily based, while the general distribution is based on the best available scientific information, as well as fishery and local knowledge of a species life stage.

5. There is no discrete basis for the distinction between known concentrations and general distribution of a species' life stage.

6. Observed concentrations or densities do not necessarily reflect all habitat essential to maintain healthy stocks within the ecosystem.

The advice in the NMFS guidelines to use risk-averse and ecosystem approaches and the best scientific information available suggests that the general distribution should be used to designate EFH necessary to maintain healthy stocks and ecosystems and sustain productive fisheries. While areas of known concentration are identified for some species life stage, the Groundfish Technical Team recommends that EFH be defined at this time as the general distribution for all groundfish species life stages in the Gulf of Alaska, Bering Sea and Aleutian Islands.

The recommended EFH definition for each species' life stage is written in the following section and described in Tables 1-3. The habitats described in the text are located within the general distributions shown on maps for species' life stages with level 1 or 2 information. For those stages with level 1 information, only general distributions within which EFH is located are drawn on maps. For those adult groundfish with level 2 information, known concentrations are also drawn on the maps within the general distribution, however EFH is defined as the adult's general distribution. No maps are provided for those life stages with level 0 information.

For BSAI and GOA pollock, a map showing the general distribution of each life stage is provided. For all other groundfish species which have level 1 or 2 information for adult or juvenile life stages, only 1 map is provided. If the adult stage has level 2 information and the juvenile stage has level 1 information, the map

displays both the general distribution of adults and juveniles and known concentrations of adults. If only the adult stage has level 1 or 2 information, the map displays its general distribution and known concentrations (only for level 2).

Geographic references used in the written definitions of EFH for BSAI and GOA groundfish are shown in Figure 1. EFH distribution maps are drawn specific to the management areas of concern. For instance, maps of general distributions of BSAI groundfish show the distribution of EFH only in the BSAI region, which includes only management areas between 500-543; it is not drawn east of 170°W south of the Aleutian Islands since that is in the GOA region (management areas between 600-680; Figure 2). Similarly, EFH is not drawn beyond the boundaries of the U.S. Exclusive Economic Zone (EEZ).

References

Allen, M. J., and G. B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and northeastern Pacific. U.S. Dep. Commerc., NOAA Tech. Rept. NMFS 66, 151 p.

Eschmeyer, W. N., and E. S. Herald. 1983. A field guide to Pacific coast fishes. Houghton Mifflin Co., Boston. 336 p.

Fritz, L. W., A. Greig, and R. Reuter. Catch-per-unit-effort, length, and depth distributions of major groundfish and bycatch species in the Bering Sea, Aleutian Islands and Gulf of Alaska regions based on groundfish fishery observer data. U.S. Dep. Commerc., NOAA Tech. Memo. NMFS-AFSC. In press (a).

Fritz, L. W., A. Greig, and R. Reuter. Catch-per-unit-effort, length, and depth distributions of major groundfish and bycatch species in the Bering Sea, Aleutian Islands and Gulf of Alaska regions based on research trawl survey data. U.S. Dep. Commerc., NOAA Tech. Memo. NMFS-AFSC. In press (b).

Hart, J. L. 1973. Pacific fishes of Canada. Fisheries Research Board of Canada Bulletin 180. Ottawa. 740 p.

NOAA. 1987. Bering, Chukchi, and Beaufort Seas. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dep. Commerc., NOAA, NOS.

NOAA. 1990. West coast of North America. Coastal and ocean zones, Strategic assessment: Data atlas. U.S. Dep. Commerc., NOAA, NOS.

NPFMC. 1997a. Essential fish habitat assessment report for the groundfish resources of the Bering Sea and Aleutian Islands regions. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

NPFMC. 1997b. Essential fish habitat assessment report for the groundfish resources of the Gulf of Alaska region. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Wolotira, R. J., Jr., T. M. Sample, S. F. Noel, and C. R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-1984. U.S. Dep. Commerc., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Table 1. Summary of habitat associations for groundfish in the BSAI and GOA.

Table 1 (continued). Summary of habitat associations for groundfish in the BSAI and GOA.

Table 1 (continued). Summary of habitat associations for groundfish in the BSAI and GOA.

Table 1 (continued). Summary of habitat associations for groundfish in the BSAI and GOA.

Table 2. Summary of biological associations for groundfish in the BSAI and GOA.

Table 2 (continued). Summary of biological associations for groundfish in the BSAI and GOA.

Table 2 (continued). Summary of biological associations for groundfish in the BSAI and GOA.

Table 2 (continued). Summary of biological associations for groundfish in the BSAI and GOA.

Table 3. Summary of reproductive traits for groundfish in the BSAI and GOA.

Table 3 (continued). Summary of reproductive traits for groundfish in the BSAI and GOA.

Table 4. References Used to Draw Maps for BSAI Groundfish

Species	References					
	Allen and Smith 1988	Fritz et al. In press (a)	Fritz et al. In press (b)	NOAA 1987	NOAA 1990	Wolotira et al. 1993
Walleye pollock	X	X	X	X	X	X
Pacific cod	X	X	X	X	X	X
Yellowfin sole	X	X	X	X		X
Greenland turbot	X	X	X	X		X
Arrowtooth flounder	X	X	X	X	X	X
Rock sole	X	X	X	X		X
Alaska plaice	X	X	X	X		X
Flathead sole	X	X	X	X	X	X
Sablefish	X	X	X		X	X
Pacific ocean perch	X	X	X		X	X
Shortraker-rougheye rockfish	X	X	X			
Northern rockfish	X	X	X			
Dusky rockfish	X	X	X			
Thornyhead rockfish	X	X	X			
Atka mackerel	X	X	X		X	X
Sculpins	X	X	X			
Skates	X	X	X			

Habitat Description for Walleye pollock (*Theragra calcogramma)*

Management Plan and Area Eastern Bering Sea-Aleutian Islands (BSAI) and Gulf of Alaska (GOA)

The Gulf of Alaska are managed under the Gulf of Alaska Groundfish Fisheries Management Plan and the Eastern Bering Sea and Aleutian Islands pollock stocks are managed under the Eastern Bering Sea and Aleutian Islands Groundfish Fisheries Management Plan. Pollock occur throughout the area covered by the FMP and straddle into the Canadian and Russian EEZ, international waters of the central Bering Sea, and into the Chukchi Sea.

Life History and General Distribution

Pollock is the most abundant species within the eastern Bering Sea comprising 75-80% of the catch and 60% of the biomass. In the Gulf of Alaska, pollock is the second most abundant groundfish stock comprising 25-50% of the catch and 20% of the biomass.

Four stocks of pollock are recognized for management purposes: Gulf of Alaska, eastern Bering Sea, Aleutian Islands, and Aleutian Basin. There appears to be a high degree of interrelationship among the eastern Bering Sea, Aleutian Islands, and Aleutian Basin stocks with suggestions of movement from one area to the others. There appears to be stock separation between the Gulf of Alaska stocks and stocks to the north.

The most abundant stock of pollock is the eastern Bering Sea stock which is primarily distributed over the eastern Bering Sea outer continental shelf between approximately 70-200 m. Information on pollock distribution in the eastern Bering Sea comes from commercial fishing locations, annual bottom trawl surveys and triennial acoustic surveys.

The Aleutian Islands stock extends through the Aleutian Islands from 170° W to the end of the Aleutian Islands (Attu Island), with the greatest abundance in the eastern Aleutians (170° W to Seguam Pass). Most of the information on pollock distribution in the Aleutian Islands comes from triennial bottom trawl surveys. These surveys indicate that pollock are primarily located on the Bering Sea side of the Aleutian Islands, and have a spotty distribution throughout the Aleutian Islands chain. The bottom trawl data may not provide an accurate view of pollock distribution because a significant portion of the pollock biomass may be pelagic and not available to bottom trawls, and secondly many areas of the Aleutian Islands shelf are untrawlable due to rough bottom.

The third stock, Aleutian Basin, appears to be distributed throughout the Aleutian Basin which encompasses the U.S. EEZ, Russian EEZ, and international waters in the central Bering Sea. This stock appears to move throughout the Basin for feeding, but concentrate in deepwater near the continental shelf for spawning. The principal spawning location is near Bogoslof Island in the eastern Aleutian Islands, but data from pollock fisheries in the first quarter of the year indicate that there are other concentrations of deepwater spawning concentrations in the western Aleutian Islands. The Aleutian Basin spawning stock appears to be derived from migrants from the eastern Bering Sea shelf stock, and possibly some western Bering Sea pollock. Recruitment to the stock occurs generally around age 5, very few pollock younger than age 5 have been found in the Aleutian Basin. Most of the pollock in the Aleutian Basin appear to originate from strong year classes.

The Gulf of Alaska stock extends from southeast Alaska to the Aleutian Islands (170° W), with the greatest abundance in the western and central regulatory areas (147° W to 170° W). Most of the information on pollock distribution in the Gulf of Alaska comes from triennial bottom trawl surveys. These surveys indicate that pollock are distributed throughout the shelf regions of the Gulf of Alaska at depths less than 300 m. The

bottom trawl data may not provide an accurate view of pollock distribution because a significant portion of the pollock biomass may be pelagic and not available to bottom trawls. The principal spawning location is in Shelikof Strait, but data from pollock fisheries and exploratory surveys indicate that there are other concentrations of spawning in the Shumagin Islands, the east side of Kodiak Island and near Prince William Sound.

Peak pollock spawning occurs on the southeastern Bering Sea and eastern Aleutian Islands along the outer continental shelf around mid-March. North of the Pribilof Islands spawning occurs later (April-May) in smaller spawning aggregations. The deep spawning pollock of the Aleutian Basin appear to spawn slightly earlier, late February-early March. In the Gulf of Alaska, peak spawning occurs in late March in Shelikof Strait. Peak spawning in the Shumagin area appears to 2-3 weeks earlier than in Shelikof Strait.

Spawning occurs pelagically and eggs develop throughout the water column (70-80 m in the Bering Sea shelf, 150-200 m in Shelikof Strait). Development is dependent on water temperature. In the Bering Sea, eggs take about 17-20 days to develop at 4 degrees in the Bogoslof area and 25.5 days at 2 degrees on the shelf. In the Gulf of Alaska, development takes approximately 2 weeks at ambient temperature (5 degrees C). Larvae are also distributed in the upper water column. In the Bering Sea the larval period lasts approximately 60 days. The larvae eat progressively larger naupliar stages of copepods as they grow and then small euphausiids as they approach transformation to juveniles (~25 mm standard length). In the Gulf of Alaska, larvae are distributed in the upper 40 m of the water column and the diet is similar to Bering Sea larvae. FOCI survey data indicate larval pollock may utilize the stratified warmer upper waters of the mid-shelf to avoid predation by adult pollock which reside in the colder bottom water.

At age 1 pollock are found throughout the eastern Bering Sea both pelagically and on bottom. Age 1 pollock from strong year-classes appear to be found in great numbers on the inner shelf, and further north on the shelf than weak year classes which appear to be more concentrated on the outer continental shelf. From age 2-3 pollock are primarily pelagic and then to be most abundant on the outer and mid-shelf northwest of the Pribilof Islands. As pollock reach maturity (age 4) in the Bering Sea, they appear to move from the northwest to the southeast shelf to recruit to the adult spawning population. Strong year-classes of pollock persist in the population in significant numbers until about age 12, and very few pollock survive beyond age 16. The oldest recorded pollock was age 31.

Growth varies by area with the largest pollock occurring on the southeastern shelf. On the northwest shelf the growth rate is slower. A newly maturing pollock is around 40 cm.

Age	Mean length (cm)			Mean weight (kg)	Maturity
	Southeast Shelf	Northwest Shelf	eastern Bering Sea	eastern Bering Sea	
2	29.8	25.9	28.2	0.170	1%
3	36.1	31.9	34.5	0.303	29%
4	41.1	36.7	39.5	0.447	64%
5	45.1	40.6	43.4	0.589	84%
6	48.2	43.7	46.6	0.722	90%
7	50.7	46.2	49.1	0.840	95%
8	52.6	48.3	51.1	0.942	96%
9	54.2	49.9	52.7	1.029	97%
10	55.4	51.2	54.0	1.102	97%
11	56.4	52.3	55.0	1.163	100%
12	57.1	53.1	55.8	1.212	100%
13	57.7	53.8	56.5	1.253	100%
14	58.2	54.4	57.0	1.286	100%
15	58.6	54.8	57.4	1.312	100%

Age	Gulf of Alaska		
	Mean length	Mean Weight	Maturity
2	27.7	0.186	3%
3	35.6	0.380	12%
4	41.2	0.579	33%
5	45.3	0.760	64%
6	48.3	0.911	87%
7	50.4	1.033	96%
8	52.0	1.129	99%
9	53.1	1.204	100%
10	54.0	1.261	100%
11	54.6	1.305	100%
12	55.1	1.338	100%
13	55.4	1.253	100%
14	55.7	1.286	100%
15	55.9	1.312	100%

Fishery

The eastern Bering Sea pollock fishery has, since 1990 been divided into two fishing periods; an "A season" occurring in January-March, and a "B season" occurring in August-October. The A season concentrates fishing effort on prespawning pollock in the southeastern Bering Sea. During the B season fishing is still primarily in the southeastern Bering Sea, but some fishing also occurs on the northwestern shelf. Also during the B season catcher processor vessels are required to fish north of 56° N latitude because the area to the south is reserved for catcher vessels delivering to shoreside processing plants on Unalaska and Akutan.

Since 1990, the Gulf of Alaska pollock Total Allowable Catch (TAC) has been divided into four regions; the Shumagin International North Pacific Fishery Commission (INPFC) area, the Chirikof INPFC area, the Kodiak INPFC area and the eastern Gulf of Alaska (east of 147° W). From 1990 to 1995 the TAC was divided into four quarterly fishing seasons with openers in January, June, July and October. In 1996, the TAC was divided into three fishing seasons with openers in January, June and September. One hundred percent of the catch is allocated to shoreside processing plants with the majority of the catch being processed on Kodiak Island.

Nearly the entire harvest of pollock is taken with pelagic trawl gear. In 1996 pelagic trawls took 91% of the pollock harvest. The pollock fishery has a very low bycatch rate with discards 10% or less since 1992. Most of the discards in the pollock fishery are juvenile pollock, or pollock too large to fit filleting machines. In the pelagic trawl fishery the catch is almost exclusively pollock, but in the bottom trawl pollock fishery the bycatch of other species is higher. Between 1991 and 1994 the bycatch of other species was 18% in the bottom trawl pollock fishery, and 3% in the pelagic trawl pollock fishery. Most of the bycatch was Pacific cod and flatfish species.

The eastern Bering Sea pollock fishery primarily harvests mature pollock. The 50% selectivity corresponds to the age of 50% maturity, age 4. Fishery selectivity increases to a maximum around age 7-8 and then declines. The reduced selectivity for older ages is due to pollock becoming increasingly demersal with age. Younger pollock form large schools and are semi-demersal, thereby being easier to locate by fishing vessels. Immature fish (ages 2 and 3) are usually caught in low numbers. Generally the catch of immature pollock increases when strong year-classes occur and the abundance of juveniles increase sharply. This occurred with the 1989 year-class, the second largest year-class on record. Juvenile bycatch increased sharply in 1991 and

1992 when this year-class was age 2 and 3. A secondary problem is that strong to moderate year-classes may reside in the Russian EEZ adjacent to the U. S. EEZ as juveniles. Russian catch-age data and anecdotal information suggest that juveniles may comprise a major portion of the catch. There is a potential for the Russian fishery to reduce subsequent abundance in the U. S. fishery.

Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Selectivity	5%	27%	50%	70%	90%	100%	88%	89%	77%	79%	79%	77%	87%	87%

The Gulf of Alaska pollock fishery also targets mature pollock. Fishery selectivity increases to a maximum around age 5-7 and then declines. The selectivity pattern varies between years due to shifts in fishing strategy.

Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Selectivity	6%	19%	45%	77%	100	97%	67%	38%	21%	21%	21%	21%	21%	21%

Relevant Trophic Information

Juvenile pollock through newly maturing pollock primarily utilize copepods and euphausiids for food. At maturation and older ages pollock become increasingly piscivorous, with pollock (cannibalism) a major food item in the Bering Sea. Most of the pollock consumed by pollock are age 0 and 1 pollock, and recent research suggests that cannibalism can regulate year-class size. Weak year-classes appear to be those located within the range of adults, while strong year-classes are those that are transported to areas outside the range of adult abundance.

Being the dominant species in the eastern Bering Sea pollock is an important food source for other fish, marine mammals, and birds. On the Pribilof Islands hatching success and fledgling survival of marine birds has been tied to the availability of age 0 pollock to nesting birds.

Upper size limit of juvenile fish

The upper size limit for juvenile pollock in the eastern Bering Sea and Gulf of Alaska is about 38-42 cm. This is the size of 50% maturity.

Sources for additional distribution data

Eggs and Larvae:

Art Kendall, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA, 206-526-4108.

Richard Brodeur, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA, 206-526-4318.

Shallow water concentrations:

Bill Bechtol, Alaska Department of Fish and Game, 3298 Douglas Place, Homer, Alaska 99603-8027.

Habitat and Biological Associations

Egg-Spawning: Pelagic on outer continental shelf generally over 100-200 m depth in Bering Sea. Pelagic on continental shelf over 100-200 m depth in Gulf of Alaska.

Larvae: Pelagic outer to mid-shelf region in Bering Sea. Pelagic throughout the continental shelf within the top 40 m in the Gulf of Alaska.

Juveniles: Age 0 appears to be pelagic, as is age 2 and 3. Age 1 pelagic and demersal with a widespread distribution and no known benthic habitat preference.

Adults: Adults occur both pelagically and demersally on the outer and mid-continental shelf of the Gulf of Alaska, eastern Bering Sea and Aleutian Islands. In the eastern Bering Sea few adult pollock occur in waters shallower than 70 m. Adult pollock also occur pelagically in the Aleutian Basin. Adult pollock range throughout the Bering Sea in both the U.S. and Russian waters, however, the maps provided for this document detail distributions for pollock in the U.S. Exclusive Economic Zone and the basin.

Literature

Bailey, K.M., S.J. Picquelle, and S.M. Spring. 1996. Mortality of larval walleye pollock (*Theragra chalcogramma*) in the western Gulf of Alaska, 1988-91. Fish. Oceanogr. 5 (Suppl. 1):124-136.

Bakkala, R.G., V.G. Wespestad and L.L. Low. 1987. Historical trends in abundance and current condition of walleye pollock in the eastern Bering Sea. Fish. Res.,5:199-215.

Bates, R.D. 1987. Ichthyoplankton of the Gulf of Alaska near Kodiak Island, April-May 1984. NWAFC Proc. Rep. 87-11, 53 pp.

Brodeur, R.D. and M.T. Wilson. 1996. A review of the distribution, ecology and population dynamics of age-0 walleye pollock in the Gulf of Alaska. Fish. Oceanogr. 5 (Suppl. 1):148-166.

Brown, A.L. and K.M. Bailey. 1992. Otolith analysis of juvenile walleye pollock (*Theragra chalcogramma*) from the western Gulf of Alaska. Mar. Bio. 112:23-30.

Fritz, L.W. 1993. Trawl locations of walleye pollock and Atka mackerel fisheries in the Bering Sea, Aleutian Islands, and Gulf of Alaska from 1977-1992. AFSC Processed Report 93-08, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115 162p.

Fritz, L.W., V.G. Wespestad, and J.S. Collie. 1993. Distribution and abundance trends of forage fishes in the Bering Sea and Gulf of Alaska. Pages 30-43 in Is it food?: addressing marine mammal and sea bird declines. Workshop Summary, Alaska Sea Grant Rept. 93-01. Univ. Alaska, Fairbanks, AK.

Kendall, A.W., Jr. and S.J. Picquelle. 1990. Egg and larval distributions of walleye pollock *Theragra chalcogramma* in Shelikof Strait, Gulf of Alaska. U.S. Fish. Bull. 88(1):133-154.

Kim, S. and A.W. Kendall, Jr. 1989. Distribution and transport of larval walleye pollock (*Theragra chalcogramma*) in Shelikof Strait, Gulf of Alaska, in relation to water movement. Rapp. P.-v. Reun. Cons. int. Explor. Mer 191:127-136.

Livingston, P.A. 1991. Groundfish food habits and predation on commercially important prey species in the eastern Bering Sea from 1884-1986. U. S. Dept. Commerce, NOAA Tech Memo. NMFS F/NWC-207.

Rugen, W.C. 1990. Spatial and temporal distribution of larval fish in the western Gulf of Alaska, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*) larvae. NWAFC Proc. Rep. 90-01, 162 pp.

Shima, M. 1996. A study of the interaction between walleye pollock and Steller sea lions in the Gulf of Alaska. Ph.D. dissertation, University of Washington, Seattle, WA 98195.

Stabeno, P.J., J.D. Schumacher, K.M. Bailey, R.D. Brodeur, and E.D. Cokelet. 1996. Observed patches of walleye pollock eggs and larvae in Shelikof Strait, Alaska: their characteristics, formation and persistence. Fish. Oceanogr. 5(Suppl. 1): 81-91.

Wespestad, V.G. 1993. The status of Bering Sea pollock and the effect of the "Donut Hole" fishery. Fisheries 18(3)18-25.

Wespestad V.G. and T.J. Quinn. II. 1997. Importance of cannibalism in the population dynamics of walleye pollock. In: Ecology of Juvenile Walleye Pollock, *Theragra chalcogramma*. NOAA Technical Report, NMFS 126.

Wespestad, V.G., James Ianelli, Lowell Fritz, Taina Honkalehto, Gary Walters. 1996. Bering Sea-Aleutian Islands Walleye Pollock Assessment for 1997. North Pac. Fish. Mgt. Counc., Anchorage, AK. p.1:1-35.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-84. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-6, 184 pp.

SPECIES: Bering Sea/Aleutian Islands Walleye Pollock

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	17-20 d. at 4C	None	Feb-Apr	OCS, UCS	P	N/A	G?	
Larvae	60 days	copepod naupli and small euphausiids	Mar-Jul	OCS	P	N/A	G? F	pollock larvae with jellyfish
Juveniles	Age 0.4 to Age 4	Pelagic crustaceans, copepods and euphausiids	Aug. +	OCS, MCS, ICS	P, SD	N/A	CL, F	
Adults	Age 4 - 16	Pelagic crustaceans and fish, primarily juvenile pollock	Spawning Feb-Apr	OCS, BSN	P, SD	UNK	F UP	Increasingly demersal with age. Appears to prefer 2-3°C water for spawning.

Habitat Description for Pacific cod
Gadus macrocephalus

Management Plan and Area(s) Groundfish, BSAI and GOA

Life History and General Distribution

Pacific cod is a transoceanic species, occurring at depths from shoreline to 500 m. The southern limit of the species' distribution is about 34° N latitude, with a northern limit of about 63° N latitude. Adults are demersal and form aggregations during the peak spawning season, which extends approximately from January through May. Pacific cod eggs are demersal and adhesive. Eggs hatch in about 15-20 days. Little is known about the distribution of Pacific cod larvae, which undergo metaphorphosis at about 25-35 mm. Juvenile Pacific cod start appearing in trawl surveys at a fairly small size, as small as 10 cm in the eastern Bering Sea. Pacific cod can grow to be more than a meter in length, with weights in excess of 10 kg. Natural mortality is believed to be somewhere between 0.3 and 0.4. Approximately 50% of Pacific cod are mature by ages 5-6. The maximum recorded age of a Pacific cod from the Bering Sea/Aleutian Islands (BSAI) or Gulf of Alaska (GOA) is 19 years.

Fishery

The fishery is conducted with bottom trawl, longline, pot, and jig gear. The age at 50% recruitment varies between gear types and regions. In the BSAI, the age at 50% recruitment is 3 years for trawl gear and 4 years for other longline and pot gear. In the GOA, the age at 50% recruitment is 4 years for trawl gear and 5 years for longline and pot gear. More than 100 vessels participated in each of the three largest fisheries (trawl, longline, pot). The trawl fishery is typically concentrated during the first few months of the year, whereas fixed-gear fisheries may sometimes run essentially year-round. Bycatch of crab and halibut often causes the Pacific cod fisheries to close prior to reaching the total allowable catch. In the BSAI, trawl fishing is concentrated immediately north of Unimak Island, whereas the longline fishery is distributed along the shelf edge to the north and west of the Pribilof Islands. In the GOA, the trawl fishery has centers of activity around the Shumagin Islands and south of Kodiak Island, while the longline fishery is located primarily in the vicinity of the Shumagins.

Relevant Trophic Information

Pacific cod are omnivorous. In terms of percent occurrence, the most important items in the diet of Pacific cod in the BSAI and GOA are polychaetes, amphipods, and crangonid shrimp. In terms of numbers of individual organisms consumed, the most important dietary items are euphausiids, miscellaneous fishes, and amphipods. In terms of weight of organisms consumed, the most important dietary items are walleye pollock, fishery discards, and yellowfin sole. Small Pacific cod feed mostly on invertebrates, while large Pacific cod are mainly piscivorous. Predators of Pacific cod include halibut, salmon shark, northern fur seals, sea lions, harbor porpoises, various whale species, and tufted puffin.

What is the approximate upper size limit of juvenile fish (in cm)? The estimated size at 50% maturity is 67 cm.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Larvae/juveniles: NMFS, Alaska Fisheries Science Center, FOCI Program, Ann Matarese 206-526-4111

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Spawning takes place in the sublittoral-bathyal zone (40-290 m) near bottom. Eggs sink to the bottom after fertilization, and are somewhat adhesive. Optimal temperature for incubation is 3-6° C, optimal salinity is 13-23 ppt, and optimal oxygen concentration is from 2-3 ppm to saturation. Little is known about the optimal substrate type for egg incubation.

Larvae: Larvae are epipelagic, occurring primarily in the upper 45 m of the water column shortly after hatching, moving downward in the water column as they grow.

Juveniles: Juveniles occur mostly over the inner continental shelf at depths of 60-150 m.

Adults: Adults occur in depths from the shoreline to 500 m. Average depth of occurrence tends to vary directly with age for at least the first few years of life, with mature fish concentrated on the outer continental shelf. Preferred substrate is soft sediment, from mud and clay to sand.

Literature

Albers, W.D., and P.J. Anderson. 1985. Diet of Pacific cod, *Gadus macrocephalus*, and predation on the northern pink shrimp, *Pandalus borealis*, in Pavlof Bay, Alaska. Fish. Bull., U.S. 83:601-610.

Alderdice, D.F., and C.R. Forrester. 1971. Effects of salinity, temperature, and dissolved oxygen on early development of the Pacific cod (*Gadus macrocephalus*). J. Fish. Res. Board Can. 28:883-902.

Bakkala, R.G. 1984. Pacific cod of the eastern Bering Sea. Int. N. Pac. Fish. Comm. Bull. 42:157-179.

Dunn, J.R., and A.C. Matarese. 1987. A review of the early life history of northeast Pacific gadoid fishes. Fish. Res. 5:163-184.

Forrester, C.R., and D.F. Alderdice. 1966. Effects of salinity and temperature on embryonic development of Pacific cod (*Gadus macrocephalus*). J. Fish. Res. Board Can. 23:319-340.

Hirschberger, W.A., and G.B. Smith. 1983. Spawning of twelve groundfish species in Alaska and Pacific Coast regions, 1975-81. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS F/NWC-44. 50 p.

Ketchen, K.S. 1961. Observations on the ecology of the Pacific cod (*Gadus macrocephalus*) in Canadian waters. J. Fish. Res. Board Can. 18:513-558.

Livingston, P.A. 1989. Interannual trends in Pacific cod, *Gadus macrocephalus*, predation on three commercially important crab species in the eastern Bering Sea. Fish. Bull., U.S. 87:807-827.

Livingston, P.A. 1991. Pacific cod. *In* P.A. Livingston (editor), Groundfish food habits and predation on commercially important prey species in the eastern Bering Sea from 1984 to 1986, p. 31-88. U.S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-207.

Matarese, A.C., A.W. Kendall Jr., D.M. Blood, and B.M. Vinter. 1989. Laboratory guide to early life history stages of northeast Pacific fishes. U.S. Dept. Commerce, NOAA Tech. Rep. NMFS 80. 652 p.

Moiseev, P.A. 1953. Cod and flounders of far eastern waters. Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 40. 287 p. (Transl. from Russian: Fish. Res. Board Can. Transl. Ser. 119.)

National Oceanic and Atmospheric Administration (NOAA). 1987. Bering, Chukchi, and Beaufort Seas--Coastal and ocean zones strategic assessment: Data Atlas. U.S. Dept. Commerce, NOAA, National Ocean Service.

National Oceanic and Atmospheric Administration (NOAA). 1990. West coast of North America--Coastal and ocean zones strategic assessment: Data Atlas. U.S. Dept. Commerce, NOAA, National Ocean Service and National Marine Fisheries Service.

Phillips, A.C., and J.C. Mason. 1986. A towed, self-adjusting sld sampler for demersal fish eggs and larvae. Fish. Res. 4:235-242.

Rugen, W.C., and A.C. Matarese. 1988. Spatial and temporal distribution and relative abundance of Pacific cod (*Gadus macrocephalus*) larvae in the western Gulf of Alaska. NWAFC Proc. Rep. 88-18. Available from Alaska Fish. Sci. Center, 7600 Sand Point Way NE., Seattle, WA 98115-0070.

Thompson, G.G., and M.W. Dorn. 1996. Pacific cod. *In* Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, Plan Team for the Groundfish Fisheries of the Gulf of Alaska (editor), p. 97-134. Available from North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Thompson, G.G., H.H. Zenger, and M.W. Dorn. 1996. Pacific cod. *In* Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions, Plan Team for the Groundfish Fisheries of the Bering Sea and Aleutian Islands (editor), p. 115-148. Available from North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Westrheim, S.J. 1996. On the Pacific cod (*Gadus macrocephalus*) in British Columbia waters, and a comparison with Pacific cod elsewhere, and Atlantic cod (*G. morhua*). Can. Tech. Rep. Fish. Aquat. Sci. 2092. 390 p.

SPECIES: Pacific cod

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	15-20 d	NA	winter-spring	ICS, MCS, OCS	D	M, SM, MS ,S	U	optimum 3-6°C optimum 13-23 ppt
Larvae	U	copepods (?)	winter-spring	U	P (?)	U	U	
Early Juveniles	to 2 yrs	small invertebrates (mysids, euphausiids, shrimp)	all year	ICS, MCS	D	M, SM, MS, S	U	
Late Juveniles	to 5 yrs	pollock, flatfish, fishery discards, crab	all year	ICS, MCS, OCS	D	M, SM, MS, S	U	
Adults	5+ yr	pollock, flatfish, fishery discards, crab	spawning (Jan-May) non-spawning (Jun-Dec)	ICS, MCS, OCS ICS, MCS, OCS	D	M, SM, MS, S	U	

Habitat Description for Yellowfin sole
(Limanda aspera)

Management Plan and Area Groundfish, Bering Sea/Aleutian Islands (BSAI)

Life History and General Distribution

Distributed in North American waters from off British Columbia, Canada, (approx. lat. 49° N) to the Chukchi Sea (about lat. 70° N) and south along the Asian coast to about lat. 35° N off the South Korean coast in the Sea of Japan. Adults exhibit a benthic lifestyle and occupy separate winter spawning and summertime feeding distributions on the eastern Bering Sea shelf. From over-winter grounds near the shelf margins, adults begin a migration onto the inner shelf in April or early May each year for spawning and feeding. A protracted and variable spawning period may range from as early as late May through August occurring primarily in shallow water. Fecundity varies with size and was reported to range from 1.3 to 3.3 million eggs for fish 25-45 cm long. Eggs have been found to the limits of inshore ichthyoplankton sampling over a widespread area to at least as far north as Nunivak Island. Larvae have been measured at 2.2-5.5 mm in July and 2.5-12.3 mm in late August - early September. The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in shallow areas until they reach approximately 15 cm. The estimated age of 50% maturity is 10.5 yrs (approx. 29 cm) for females based on samples collected in 1992 and 1993. Natural mortality rate is believed to range from 0.12-0.16.

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 6 and they are fully selected at age 13. Historically, the fishery has occurred throughout the mid and inner Bering Sea shelf during ice-free conditions although much effort has been directed at the spawning concentrations in nearshore northern Bristol Bay. They are caught as bycatch in Pacific cod, bottom pollock and other flatfish fisheries and are caught with these species and Pacific halibut in yellowfin sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod, skates and Pacific halibut, mostly on fish ranging from 7 to 25 cm standard length.

Approximate upper size limit of juvenile fish? 27 cm

Habitat and Biological Associations

> *Larvae/Juveniles*: Planktonic larvae for at least 2-3 months until metamorphosis occurs, usually inhabiting shallow areas.
>
> *Adults*: Summertime spawning and feeding on sandy substrates of the eastern Bering Sea shelf. Widespread distribution mainly on the middle and inner portion of the shelf, feeding mainly on bivalves, polychaetes, amphipods and echiurids.. Wintertime migration to deeper waters of the shelf margin to avoid extreme cold water temperatures, feeding diminishes.

Literature

Auster, P.J., Malatesta, R.J., Langton, R.W., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Bakkala, R.G., V.G. Wespestad, and L.L. Low. 1982. The yellowfin sole (*Limanda aspera*) resource of the eastern Bering Sea--Its current and future potential for commercial fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-33, 43 p.

Fadeev, N.W. 1965. Comparative outline of the biology of fishes in the southeastern part of the Bering Sea and condition of their resources. [In Russ.] Tr. Vses. Nauchno-issled. Inst.Morsk. Rybn. Khoz. Okeanogr. 58 (Izv. Tikhookean. Nauchno-issled Inst. Morsk. Rybn. Khoz. Okeanogr. 53):121-138. (Trans. By Isr. Prog. Sci. Transl., 1968), p 112-129. In P.A. Moiseev (Editor), Soviet Fisheries Investigations in the northeastern Pacific, Pt. IV. Avail. Natl. Tech. Inf. Serv., Springfield, VA as TT 67-51206.

Kashkina, A.A. 1965. Reproduction of yellowfin sole (*Limanda aspera*) and changes in its spawning stocks in the eastern Bering Sea. Tr. Vses. Nauchno-issled, Inst. Morsk. Rybn. Khoz. Okeanogr. 58 (Izv. Tikhookean. Nauchno-issled. Inst. Rbn. Khoz. Okeanogr. 53):191-199. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1968, p. 182-190. In P.A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part IV. Avail. Natl. Tech. Inf. Serv., Springfield, VA., as TT67-51206.

Livingston, P.A. and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the eastern Bering Sea from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Musienko, L.N. 1963. Ichthyoplankton of the Bering Sea (data of the Bering Sea expedition of 1958-59). Tr. Vses Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 48 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 50)239-269. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1968, p. 251-286. In P.A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part I. Avail. Natl. Tech. Inf. Serv., Springfield, VA, as TT67-51203.

Musienko, L.N. 1970. Reproduction and Development of Bering Sea. Tr. Vses Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 70 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 72)161-224. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1972, p. 161-224. In P.A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part V. Avail. Natl. Tech. Inf. Serv., Springfield, VA., as TT71-50127.

Nichol, D.G. 1994. Maturation and Spawning of female yellowfin sole in the Eastern Bering Sea. Preceding of the International North Pacific Flatfish Symposium, Oct. 26-28, 1994, Anchorage, AK. Alaska Sea Grant Program.

Wakabayashi, K. 1986. Interspecific feeding relationships on the continental shelf of the eastern Bering Sea, with special reference to yellowfin sole. Int. N. Pac. Fish. Comm. Bull. 47:3-30.

Waldron, K.D. 1981. Ichthyoplankton. In D.W. Hood and J.A. Calder (Editors), The eastern Bering Sea shelf: Oceanography and resources, Vol. 1, p. 471-493. U.S. Dep. Commer., NOAA, Off. Mar. Poll. Asess., U.S. Gov. Print. Off., Wash., D.C.

Wilderbuer, T.K., G.E. Walters, and R.G. Bakkala. 1992. Yellowfin sole, Pleuronectes asper, of the Eastern Bering Sea: Biological Characteristics, History of Exploitation, and Management. Mar. Fish. Rev. 54(4) p 1-18.

SPECIES: Yellowfin sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	summer	BAY BCH	P			
Larvae	2-3 months?	U phyto/zoo plankton?	summer autumn?	BAY BCH ICS	P			
Early Juveniles	to 5.5 yrs	polychaetes bivalves amphipods echiurids	all year	BAY ICS OCS	D	S[1]		
Late Juveniles	5.5 to 10 yrs	polychaetes bivalves amphipods echiurids	all year	BAY ICS OCS	D	S[1]		
Adults	10+ years	polychaetes bivalves amphipods echiurids	spawning/ feeding May-August non-spawning Nov.-April	BAY BEACH ICS ICS MCS OCS	D	S[1]	ice edge	

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Habitat Description for Greenland turbot
(Reinhardtius hippoglossoides)

Management Plan and Area Groundfish, Bering Sea/Aleutian Islands (BSAI)

Life History and General Distribution

Greenland turbot has an amphiboreal distribution, occurring in the North Atlantic and North Pacific, but not in the intervening Arctic Ocean. In the North Pacific, species abundance is centered in the eastern Bering Sea and, secondly, in the Aleutians. On the Asian side, they occur in the Gulf of Anadyr along the Bering Sea coast of Russia, in the Okhotsk Sea, around the Kurile Islands, and south to the east coast of Japan to northern Honshu Island (Hubbs and Wilimovsky 1964, Mikawa 1963, Shuntov 1965). Adults exhibit a benthic lifestyle, living in deep waters of the continental slope but are known to have a tendency to feed off the sea bottom. During their first few years as immature fish, they inhabit relatively shallow continental shelf waters (<200 m) until about age 4 or 5 before joining the adult population (200 - 1,000 m or more, Templeman 1973). Adults appear to undergo seasonal shifts in depth distribution moving deeper in winter and shallower in summer (Chumakov 1970, Shuntov 1965). Spawning is reported to occur in winter in the eastern Bering Sea and may be protracted starting in September or October and continuing until March with an apparent peak period in November to February (Shuntov 1970, Bulatov 1983). Females spawn relatively small numbers of eggs with fecundity ranging from 23,900 to 149,300 for fish 83 cm and smaller in the Bering Sea (D'yakov 1982).

Eggs and early larval stages are benthypelagic (Musienko 1970). In the Atlantic Ocean, larvae (10-18 cm) have been found in benthypelagic waters which gradually rise to the pelagic zone in correspondence to absorption of the yolk sac which is reported to occur at 15-18 mm with the onset of feeding (Pertseva-Ostroumova 1961 and Smidt 1969). The period of larval development extends from April to as late as August or September (Jensen 1935) which results in an extensive larval drift and broad dispersal from the spawning waters of the continental slope. Metamorphosis occurs in August or September at about 7-8 cm in length at which time the demersal life begins. Juveniles are reported to be quite tolerant of cold temperatures to less than zero degrees Celsius (Hognestad 1969) and have been found on the northern part of the Bering Sea shelf in summer trawl surveys (Alton et al. 1988).

The age of 50% maturity is estimated to range from 5-10 yrs (D'yakov 1982, 60 cm used in stock assessment) and a natural mortality rate of 0.18 has been used in the most recent stock assessments (Ianelli et al. 1996).

Fishery

Caught in bottom trawls and on longlines both as a directed fishery and in the pursuit of other bottom-dwelling species (primarily sablefish). Recruitment begins at about 50 and 60 cm in the trawl and longline fisheries, respectively. The fishery operates on the continental slope throughout the eastern Bering Sea and on both sides of the Aleutian Islands. Bycatch primarily occurs in the sablefish directed fisheries and also to a smaller extent in the Pacific cod fishery.

Relevant Trophic Information

Groundfish predators include Pacific cod, pollock and yellowfin sole, mostly on fish ranging from 2 to 5 cm standard length (probably age 0).

Approximate upper size limit of juvenile fish? 59 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for up to 9 months until metamorphosis occurs, usually with a widespread distribution inhabiting shallow waters. Juveniles live on continental shelf until about age 4 or 5 feeding primarily on euphausiids, polychaetes and small walleye pollock..

Adults: Inhabit continental slope waters with annual spring/fall migrations from deeper to shallower waters. Diet consists of walleye pollock and other miscellaneous fish species.

Literature

Alton, M.S., R.G. Bakkala, G.E. Walters and P.T. Munro. 1988. Greenland turbot, *Reinhardtius hippoglossoides*, of the Eastern Bering Sea and Aleutian Islands. U.S. Dept. Commer., NOAA Tech. Rpt. NMFS 71, 31 pages.

Auster, P.J., Malatesta, R.J., Langton, R.W., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Bulatov, O.A. 1983. Distribution of eggs and larvae of Greenland halibut, *Reinhardtius hippoglossoides*, (Pleuronectidae) in the eastern Bering Sea. J. Ichthyol. [Engl. Transl. Vopr. Ikhtiol.] 23(1):157-159.

Chumakov, A.K. 1970. The Greenland halibut, *Reinhardtius hippoglossoides*, in the Iceland area-The halibut fisheries and tagging. Tr. Polyarn. Nauchno-Issled. Proektn. Inst. Morsk. Rybn. Khoz. 1970:909-912.

D'yakov, Yu. P. 1982. The fecundity of the Greenland halibut, *Reinhardtius hippoglossoides* (Pleuronectidae), from the Bering Sea. J. Ichthyol. [Engl. Trans. Vopr. Ikhtiol.] 22(5):59-64.

Hognestad, P.T. 1969. Notes on Greenland halibut, *Reinhardtius hippoglossoides*, in the eastern Norwegian Sea. Fiskeridir. Skr. Ser. Havunders. 15(3):139-144.

Hubbs, C.L., and N.J. Wilimovsky. 1964. Distribution and synonymy in the Pacific Ocean and variation of the Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum). J. Fish. Res. Board Can. 21:1129-1154.

Ianelli, J.N., T.K. Wilderbuer and T.M. Sample. 1996. Greenland turbot. *In* Stock Assessment and Fishery Evaluation Report for the groundfish resources of the Bering Sea/Aleutian Islands Regions, Pages 175-208. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Jensen, A.S. 1935. (*Reinhardtius hippoglossoides*) its development and migrations. K. dan. Vidensk. Selsk. Skr. 9 Rk., 6:1-32.

Livingston, P.A. and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the eastern Bering Sea from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way, NE., Seattle, WA 98115.

Mikawa, M. 1963. Ecology of the lesser halibut, *Reinhardtius hippoglossoides matsuurae* Jordan and Snyder. Bull. Tohoku Reg. Fish. Res. Lab. 29:1-41.

Musienko, L.N. 1970. Reproduction and Development of Bering Sea. Tr. Vses Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 70 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 72)161-224. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1972, p. 161-224. In P. A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part V. Avail. Natl. Tech. Inf. Serv., Springfield, VA., as TT71-50127.

Pertseva-Ostroumova, T.A. 1961. The reproduction and development of far eastern flounders. Izdatel'stvo Akad. Nauk. SSSR, 483 p. [Transl. By Fish. Res. Board Can., 1967, Transl. Ser. 856, 1003 p.]

Shuntov, V.P. 1965. Distribution of the Greenland halibut and arrowtooth halibuts in the North Pacific. Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 58 (Izv. Tikhookean. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 53):155-163. [Transl. In Soviet Fisheries Investigation in the Northeastern Pacific, Part IV, p. 147-156, by Israel Prog. Sci. Transl., 1972, avail. Natl. Tech. Inf. Serv., Springfield, VA as TT71-50127.]

Templeman, W. 1973. Distribution and abundance of the Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum), in the Northwest Atlantic. Int. Comm. Northwest Atl. Fish. Res. Bull. 10:82-98.

SPECIES: Greenland turbot

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter	OCS MCS	SD, SP			
Larvae	8-9 months	U phyto/zoo plankton?	Spring summer	OCS ICS MCS	P			
Juveniles	1-5 yrs	euphausiids polychaets small pollock	all year	ICS MCS OCS USL	D, SD	M/S+M[1]		
Adults	5+ years	pollock small fish	spawning Nov-February non-spawning March- October	OCS USL LSL OCS USL LSL	D, SD	M/S+M[1]		

[1]Pers. Comm. Dr. Robert McConnaughey (206) 526-4150

Habitat Description for Arrowtooth flounder
(Atheresthes stomias)

Management Plan and Area Groundfish, BSAI and GOA

Life History and General Distribution

Distributed in North American waters from central California to the eastern Bering Sea on the continental shelf and upper slope.

Adults exhibit a benthic lifestyle and occupy separate winter and summer distributions on the eastern Bering Sea shelf. From over-winter grounds near the shelf margins and upper slope areas, adults begin a migration onto the middle and inner shelf in April or early May each year with the onset of warmer water temperatures. A protracted and variable spawning period may range from as early as September through March (Rickey 1994, Hosie 1976). Little is known of the fecundity of arrowtooth flounder. Larvae have been found from ichthyoplankton sampling over a widespread area of the eastern Bering Sea shelf in April and May and also on the continental shelf east of Kodiak Island during winter and spring (Waldron and Vinter 1978, Kendall and Dunn 1985). The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in shallow areas until they reach the 10-15 cm range (Martin and Clausen 1995). The estimated length at 50% maturity is 28 cm for males (4 years) and 37 cm for females (5 years) from samples collected off the Washington coast (Rickey 1994). The natural mortality rate used in stock assessments is 0.2 (Turnock et. al 1996, Wilderbuer and Sample 1996).

Fishery

Caught in bottom trawls usually in pursuit of other higher value bottom-dwelling species. Historically have been undesirable to harvest due to a flesh softening condition caused by protease enzyme activity. Recruitment begins at about age 3 and females are fully selected at age 10. They are caught as bycatch in Pacific cod, bottom Pollock, sablefish and other flatfish fisheries.

Relevant Trophic Information

Very important as a large, aggressive and abundant predator of other groundfish species. Groundfish predators include Pacific cod and pollock, mostly on small fish.

Approximate upper size limit of juvenile fish? Males 27 cm and females 37 cm.

Habitat and Biological Associations

> *Larvae/Juveniles*: Planktonic larvae for at least 2-3 months until metamorphosis occurs, juveniles usually inhabit shallow areas until about 10 cm in length.
>
> *Adults*: Widespread distribution mainly on the middle and outer portions of the continental shelf, feeding mainly on walleye pollock and other miscellaneous fish species when arrowtooth flounder attain lengths greater than 30 cm. Wintertime migration to deeper waters of the shelf margin and upper continental slope to avoid extreme cold water temperatures and for spawning.

Literature

Auster, P.J., Malatesta, R.J., Langton, R.W., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Can. Bull. 180, 740 p.

Hosie, M.J. 1976. The arrowtooth flounder. Oregon Dep. Fish. Wildl. Info. Rep. 76-3, 4 p.

Kendall, A.W. Jr. and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. NOAA Tech. Rep. NMFS 20, U. S. Dep. Commer, NOAA, Natl. Mar. Fish. Serv.

Livingston, P.A. and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the eastern Bering Sea from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Martin, M.H. and D.M. Clausen. 1995. Data report: 1993 Gulf of Alaska Bottom Trawl Survey. U.S. Dept. Commer., NOAA, Natl. Mar. Fish. Serv., NOAA Tech. Mem. NMFS-AFSC-59, 217 p.

Rickey, M.H. 1994. Maturity, spawning, and seasonal movement of arrowtooth flounder, *Atheresthes stomias*, off Washington. Fish. Bull. 93:127-138 (1995).

Turnock, B.J., T.K. Wilderbuer and E.S. Brown 1996. Arrowtooth flounder. *In* Stock Assessment and Fishery Evaluation Report for the groundfish resources of the Gulf of Alaska, Pages 161-188. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Waldron, K.D. and B.M. Vinter 1978. Ichthyoplankton of the eastern Bering Sea. U. S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv. Seattle, WA, Processed rep., 88 p.

Wilderbuer, T.K. and T.M. Brown 1996. Arrowtooth flounder. *In* Stock Assessment and Fishery Evaluation Report for the groundfish resources of the Bering Sea/Aleutian Islands, Pages 209-232. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

SPECIES: Arrowtooth flounder

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter, spring?	ICS OCS	P			
Larvae	2-3 months?	U phyto/zoo plankton?	Spring summer?	BAY ICS OCS	P			
Early Juveniles	to 2 yrs	euphausiids crustaceans amphipods pollock	all year	ICS OCS USP	D	GMS[1]		
Late Juveniles	males 2-4 yrs females 2-5 yrs	euphausiids crustaceans amphipods pollock	all year	ICS OCS USP	D	GMS[1]		
Adults	males - 4+ yrs females- 5+ yrs	pollock misc. fish Gadidae sp. Euphausiids	spawning Nov-March non-spawning April-Oct.	OCS USP ICS OCS USP BAY	D	GMS[1]	ice edge (BS)	

[1]Pers. Comm., Dr. Robert McConnaughey (206) 526-4150

Habitat Description for Rock sole
(Lepidopsetta bilineatus)

Management Plan and Area Groundfish, BSAI

Life History and General Distribution

Distributed from California waters north into the Gulf of Alaska and Bering Sea to as far north as the Gulf of Anadyr. The distribution continues along the Aleutian Islands westward to the Kamchatka Peninsula and then southward through the Okhotsk Sea to the Kurile Islands, Sea of Japan, and off Korea. Centers of abundance occur off the Kamchatka Peninsula (Shubnikov and Lisovenko 1964), British Columbia (Forrester and Thompson 1969), the central Gulf of Alaska, and in the southeastern Bering Sea (Alton and Sample 1975). Adults exhibit a benthic lifestyle and, in the eastern Bering Sea, occupy separate winter (spawning) and summertime feeding distributions on the continental shelf. Rock sole spawn during the winter-early spring period of December-March. Soviet investigations in the early 1960s established two spawning concentrations: an eastern concentration north of Unimak Island at the mouth of Bristol Bay and a western concentration eastward of the Pribilof Islands between 55°30' and 55°0'N and approximately 165°2'W (Shubnikov and Lisovenko, 1964). Rock sole spawning in the eastern and western Bering Sea was found to occur at depths of 125-250 m, close to the shelf/slope break. Spawning females deposit a mass of eggs which are demersal and adhesive (Alton and Sample 1975). Fertilization is believed to be external. Incubation time is temperature dependent and may range from 6.4 days at 11 degrees C to about 25 days at 2.9 degrees C (Forrester 1964). Newly hatched larvae are pelagic and have occurred sporadically in eastern Bering Sea plankton surveys (Waldron and Vinter, 1978). Kamchatka larvae are reportedly 20 mm in length when they assume their side-swimming, bottom-dwelling form (Alton and Sample 1975). Forrester and Thompson (1969) report that by age 1 they are found with adults on the continental shelf during summer.

In the springtime, after spawning, rock sole begin actively feeding and commence a migration to the shallow waters of the continental shelf. This migration has been observed on both the eastern (Alton and Sample, 1975) and western (Shvetsov 1978) areas of the Bering Sea. During this time they spread out and form much less dense concentrations than during the spawning period . Summertime trawl surveys indicate most of the population can be found at depths from 50-100 m (Armistead and Nichol 1993). The movement from winter/spring to summer grounds is in response to warmer temperatures in the shallow waters and the distribution of prey on the shelf seafloor (Shvetsov 1978). In September, with the onset of cooling in the northern latitudes, rock sole begin the return migration to the deeper wintering grounds. Fecundity varies with size and was reported to be 450,00 eggs for fish 42 cm long. Larvae are pelagic but their occurrence in plankton surveys in the eastern Bering Sea are rare (Musienko 1963). The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in shallow areas until they reach age 1 (Forrester 1969). The estimated age of 50% maturity is 9 yrs (approx. 35 cm) for females and natural mortality rate is believed to range from 0.18 - 0.20.

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 4 and they are fully selected at age 11. Historically, the fishery has occurred throughout the mid and inner Bering Sea shelf during ice-free conditions and on spawning concentrations north of the Alaska Peninsula during winter for their high-value roe. They are caught as bycatch in Pacific cod, bottom Pollock and other flatfish fisheries and are caught with these species and Pacific halibut in rock sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod, walleye pollock, skates, Pacific halibut and yellowfin sole, mostly on fish ranging from 5 to 15 cm standard length.

Approximate upper size limit of juvenile fish? 34 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2-3 months until metamorphosis occurs, juveniles inhabit shallow areas at least until age 1.

Adults: Summertime feeding on primarily sandy substrates of the eastern Bering Sea shelf. Widespread distribution mainly on the middle and inner portion of the shelf, feeding on bivalves, polychaetes, amphipods and miscellaneous crustaceans. Wintertime migration to deeper waters of the shelf margin for spawning and to avoid extreme cold water temperatures, feeding diminishes.

Literature

Alton, M.S. and Terry M. Sample 1976. Rock sole (Family Pleuronectidae) p. 461-474. *In*: Demersal fish and shellfish resources in the Bering Sea in the baseline year 1975. Principal investigators Walter T. Pereyra, Jerry E. Reeves, and Richard Bakkala. U.S. Dep. Comm., Natl. Oceanic Atmos. Admin., Natl. Mar. Serv., Northwest and Alaska Fish Center, Seattle, WA. Processed Rep., 619 p.

Armistead, C.E. and D.G. Nichol 1993. 1990 Bottom Trawl Survey of the Eastern Bering Sea Continental Shelf. U.S. Dep. Commer., NOAA Tech. Mem. NMFS-AFSC-7, 190 p.

Auster, P.J., Malatesta, R.J., Langton, R.W., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Forrester, C.R. 1964. Demersal Quality of fertilized eggs of rock sole. J. Fish. Res. Bd. Canada, 21(6), 1964. P. 1531.

Forrester, C.R. and J.A. Thompson 1969. Population studies on the rock sole, *Lepidopsetta bilineata*, of northern Hecate Strait British Columbia. Fish. Res. Bd. Canada, Tech. Rep. No. 108, 1969. 104 p.

Livingston, P.A. and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the eastern Bering Sea from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Musienko, L.N. 1963. Ichthyoplankton of the Bering Sea (data of the Bering Sea expedition of 1958-59). Tr. Vses Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 48 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 50)239-269. [In Russ.] Transl. By Isr. Prog. Sci. Transl., 1968, p. 251-286. In P. A. Moiseev (Editor), Soviet fisheries investigations in the northeastern Pacific, Part I. Avail. Natl. Tech. Inf. Serv., Springfield, VA., as TT67-51203.

Shubnikov, D.A. and L.A. Lisovenko 1964. Data on the biology of rock sole in the southeastern Bering Sea. Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 49 (Izv. Tikookean. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 51) : 209-214. (Transl. In Soviet Fisheries Investigations in the Northeast Pacific, Part II, p. 220-226, by Israel Program Sci. Transl., 1968, available Natl. Tech. Inf. Serv., Springfield, VA, as TT 67-51204).

Shvetsov, F.G. 1978. Distribution and migrations of the rock sole, *Lepidopsetta bilineata*, in the regions of the Okhotsk Sea coast of Paramushir and Shumshu Islands. J. Ichthol., 18 (1), 56-62, 1978.

Waldron, K.D. And B. M. Vinter 1978. Ichthyoplankton of the eastern Bering Sea. U. S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv. Seattle, WA, Processed rep., 88 p.

SPECIES: Rock sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter	OCS	D			
Larvae	2-3 months?	U phyto/zoo plankton?	winter/spring	OCS MCS ICS	P			
Early Juveniles	to 3.5 yrs	polychaetes bivalves amphipods misc. crust.	all year	BAY ICS OCS	D	S[1]		
Late Juveniles	to 9 years	polychaetes bivalves amphipods misc. crust.	all year	BAY ICS OCS	D	S[1]		
Adults	9+ years	polychaetes bivalves amphipods misc. crust.	feeding May-September spawning Dec.-April	MCS ICS MCS OCS	D	S[1]	ice edge	

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Habitat Description for Other flatfish

Management Plan and Area Groundfish, BSAI

Life History and General Distribution

The "other flatfish" species complex is made up of the following flatfishes:

Alaska plaice (*Pleuronectes quadrituberculatus*)
rex sole (*Errex zachirus*)
Dover sole (*Microstomus pacificus*)
starry flounder (*Platichthys stellatus*)
longhead dab (*Pleuronectes proboscidea*)
butter sole (*Pleuronectes isolepis*).

Alaska plaice is the most abundant and commercially important species of the complex and the description of its habitat and life history are given.

Alaska plaice inhabit continental shelf waters of the North Pacific ranging from the Gulf of Alaska to the Bering and Chukchi Seas and in Asian waters as far south as Peter the Greate Bay (Pertseva-Ostroumova 1961; Quast and Hall 1972). Adults exhibit a benthic lifestyle and live year round on the shelf and move seasonally within its limits (Fadeev 1965). From over-winter grounds near the shelf margins, adults begin a migration onto the central and northern shelf of the eastern Bering Sea, primarily at depths of less than 100 m. Spawning usually occurs in March and April on hard sandy ground (Zhang 1987). The eggs and larvae are pelagic and transparent and have been found in ichthyoplankton sampling in late spring and early summer over a widespread area of the continental shelf (Waldron and Favorite 1977).

Fecundity estimates (Fadeev 1965) indicate female fish produce an average of 56 thousand eggs at lengths of 28 to 30 cm and 313 thousand eggs at lengths of 48 to 50 cm. The age or size at metamorphosis is unknown. The estimated length of 50% maturity is 32 cm from collections made in March and 28 cm from April, which corresponds to an age of 6 to 7 years. Natural mortality rate estimates range from 0.19 to 0.22 (Wilderbuer and Zhang, in press).

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 6 and they are fully selected at age 12. The fishery occurs throughout the mid and inner Bering Sea shelf during ice-free conditions. They are caught as bycatch in Pacific cod, bottom pollock and other flatfish fisheries and are caught with these species and Pacific halibut the directed fishery.

Relevant Trophic Information

Groundfish predators include Pacific halibut (Novikov, 1964) yellowfin sole, beluga whales and fur seals Salveson 1976).

Approximate upper size limit of juvenile fish? 27 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2-3 months until metamorphosis occurs, usually inhabiting shallow areas.

Adults: Summertime feeding on sandy substrates of the eastern Bering Sea shelf. Wide-spread distribution mainly on the middle, northern portion of the shelf, feeding on polychaetes, amphipods and echiurids. Wintertime migration to deeper waters of the shelf margin to avoid extreme cold water temperatures. Feeding diminishes until spring after spawning.

Literature

Auster, P.J., Malatesta, R.J., Langton, R.W., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

Fadeev, N.W. 1965. Comparative outline of the biology of fishes in the southeastern part of the Bering Sea and condition of their resources. [In Russ.] Tr. Vses. Nauchno-issled. Inst.Morsk. Rybn. Khoz. Okeanogr. 58 (Izv.Tikhookean. Nauchno-issled Inst. Morsk. Rybn. Khoz. Okeanogr. 53):121-138. (Trans. By Isr. Prog. Sci. Transl., 1968), p 112-129. In P.A. Moiseev (Editor), Soviet Fisheries Investigations in the northeastern Pacific, Pt. IV. Avail. Natl. Tech. Inf. Serv., Springfield, Va. As TT 67-51206.

Livingston, P.A. and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the eastern Bering Sea from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Novikov, N.P. 1964. Basic elements of the biology of the Pacific Halibut (*Hippoglossoides stenolepis* Schmidt) in the Bering Sea. Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 49 (Izv. Tikhookean. Nauchno-isslled. Inst. Morsk. Rybn. Khoz. Okeanogr. 51):167-204. (Transl. In Soviet Fisheries Investigations in the Northeast Pacific, Part II, p.175-219, by Israel Program Sci. Transl., 1968, avail. Natl. Tech. Inf. Serv. Springfield, VA, as TT67-51204.)

Pertseva-Ostroumova, T.A. 1961. The reproduction and development of far eastern flounders. (Transl. By Fish. Res. Bd. Can. 1967. Transl. Ser. 856, 1003 p.).

Quast, J.C. and E.L. Hall. 1972. List of fishes of Alaska and adjacent waters with a guide to some of their literature. U.S. Dep. Commer. NOAA, Tech. Rep. NMFS SSRF-658, 48p.

Salveson, S.J. 1976. Alaska plaice. In Demersal fish and shellfish resources of the eastern Bering Sea in the baseline year 1975 (eds. W.T. Pereyra, J.E. Reeves, and R.G. Bakkala). Processed Rep., 619 p. NWAFC, NMFS, NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112.

Waldron, K.D. and F. Favorite. 1977. Ichthyoplankton of the eastern Bering Sea. In Environmental assessment of the Alaskan continental shelf, Annual reports of principal investigators for the year ending March 1977, Vol. IX. Receptors-Fish, littoral, benthos, p. 628-682. U.S. Dep. Comm., NOAA, and U.S. Dep. Int., Bur. Land. Manage.

Wilderbuer, T.K. and C.I. Zhang. (in press). Evaluation of the population dynamics and yield characteristics of Alaska plaice (Pleuronectes quadrituberculatus) in the eastern Bering Sea incorporating results of an age-structured analysis. Netherlands Journal of Sea Research.

Zhang, C.I. 1987. Biology and Population Dynamics of Alaska plaice, Pleuronectes quadriterculatus, in the Eastern Bering Sea. Phd. dissertation, University of Washington: p.1-225.

SPECIES: Alaska plaice

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	spring and summer	ICS OCS	P			
Larvae	2-4 months?	U phyto/zoo plankton?	spring and summer	ICS MCS	P			
Juveniles	up to 7 years	polychaetes amphipods echiurids	all year	ICS MCS	D	S+M[1]		
Adults	7+ years	polychaetes amphipods echiurids	spawning March-May non-spawning and feeding June.-February	ICS MCS ICS MCS	D	S+M[1]	 ice edge	

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Habitat Description for Flathead sole
(Hippoglossoides elassodon)

Management Plan and Area Groundfish, BSAI and GOA

Life History and General Distribution

Distributed from northern California, off Point Reyes, northward along the west coast of North America and throughout the Gulf of Alaska and the Bering Sea, the Kuril Islands and possibly the Okhotsk Sea (Hart 1973).

Adults exhibit a benthic lifestyle and occupy separate winter spawning and summertime feeding distributions on the eastern Bering Sea shelf and in the Gulf of Alaska. From over-winter grounds near the shelf margins, adults begin a migration onto the mid and outer continental shelf in April or May each year for feeding. The spawning period may range from as early as January but is known to occur in March and April, primarily in deeper waters near the margins of the continental shelf. Eggs are large (2.75-3.75 mm) and females have egg counts ranging from about 72,000 (20 cm fish) to almost 600,000 (38 cm fish). Eggs hatch in 9 to 20 days depending on incubation temperatures within the range of 2.4 to 9.8°C and have been found in ichthyoplankton sampling on the southern portion of the Bering Sea shelf in April and May (Waldron 1981). Larve absorb the yolk sac in 6 to 17 days but the extent of their distribution is unknown. The age or size at metamorphosis is unknown as well as the age at 50% maturity. Juveniles less than age 2 have not been found with the adult population, remaining in shallow areas. The natural mortality rate used in recent stock assessments is 0.2.

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 3. Historically, the fishery has occurred throughout the mid and outer Bering Sea shelf during ice-free conditions (mostly summer and fall). They are caught as bycatch in Pacific cod, bottom pollock and other flatfish fisheries and are caught with these species and Pacific halibut in flathead sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod, Pacific halibut, arrowtooth flounder and also cannibalism by large flathead sole, mostly on fish less than 20 cm standard length.

Approximate upper size limit of juvenile fish? Unknown age at 50% maturity.

Habitat and Biological Associations

> *Larvae/Juveniles*: Planktonic larvae for an unknown time period until metamorphosis occurs, usually inhabiting shallow areas.
>
> *Adults*: Winter spawning and summer feeding on sand and mud substrates of the continental shelf. Widespread distribution mainly on the middle and outer portion of the shelf, feeding mainly on ophiuroids, tanner crab, osmerids, bivalves and polychaetes.

Literature

Auster, P.J., Malatesta, R.J., Langton, R.W., L. Watling, P.C. Valentine, C.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on sea floor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Rev. in Fish. Sci. 4(2): 185-202.

English, T.S. 1966 English sole egg studies. Contract Rep. Northwest Pulp Pap. Assoc. 93 p.

Forrester, C.R. and D.F. Alderdice. 1967. Preliminary observations on embryonic development of the flathead sole (*Hippoglossoides elassodon*). Fish. Res. Board Can. Tech. Rep. 100: 20 p

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Canada, Bull. No. 180. 740 p.

Livingston, P.A. and Y. DeReynier. 1996. Groundfish food habits and predation on commercially important prey species in the eastern Bering Sea from 1990 to 1992. AFSC processed Rep. 96-04, 51 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.

Miller, B.S. 1969. Life history observations on normal and tumor bearing flathead sole in East Sound, Orcas Island (Washington). Ph.D. Thesis. Univ. Wash. 131 p.

Pacunski, R.E. 1990. Food habits of flathead sole (*Hippoglossoides elassodon*) in the eastern Bering Sea. M.S. Thesis. Univ. Wash. 106 p.

Waldron, K.D. 1981. Ichthyoplankton. In D.W. Hood and J.A. Calder (Editors), The eastern Bering Sea shelf: Oceanography and resources, Vol. 1, p. 471-493. U.S. Dep. Commer., NOAA, Off. Mar. Poll. Asess., U.S. Gov. Print. Off., Wash., D.C.

Walters, G.E. and T.K. Wilderbuer 1996. Flathead sole. *In* Stock assessment and fishery evaluation Report for the groundfish resources of the Bering Sea/Aleutian Islands Regions. p 279-290. North Pacific Fishery Management Council, 605 West 4th Ave., Suite 306, Anchorage, AK 99501.

SPECIES: Flathead sole

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter	ICS MCS OCS	P			
Larvae	U	U phyto/zoo plankton?	spring summer	ICS MCS OCS	P			
Early Juveniles	to 2 yrs	polychaetes bivalves ophiuroids pollock and Tanner crab	all year	MCS ICS OCS	D	S+M[1]		
Late Juveniles	3 yrs	polychaetes bivalves ophiuroids pollock and Tanner crab	all year	MCS ICS OCS	D	S+M[1]		
Adults	U	polychaetes bivalves ophiuroids pollock and Tanner crab	spawning Jan-April non-spawning May-December	MCS OCS ICS ICS MCS OCS	D	S+M[1]	ice edge	

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Habitat Description for Sablefish or Black Cod
(Anoplopoma fimbria)

Management Plan and Area(s) Groundfish, GOA and BSAI

Life History and General Distribution

Distributed from Mexico through the Gulf of Alaska to the Aleutian Chain, Bering Sea; along the Asian coast from Sagami Bay, and along the Pacific sides of Honshu and Hokkaido Islands and the Kamchatkan Peninsula. Adult sablefish occur along the continental slope, shelf gulleys, and in deep fjords such as Prince William Sound and Southeastern Alaska, at depths generally greater than 200 m. Adults are assumed to be demersal. Spawning or very ripe sablefish are observed in late winter or early spring along the continental slope. Eggs are apparently released near the bottom where they incubate. After hatching and yolk adsorption the larvae rise to the surface where they have been collected with neuston nets. Larvae are oceanic through the spring and by late summer, small pelagic juveniles (10-15 cm) have been observed along the outer coasts of Southeast Alaska, where they apparently move into shallow waters to spend their first winter. During most years, there are only a few places where juveniles have been found during their first winter and second summer. It is not clear if the juvenile distribution is highly specific or appears so because sampling is highly inefficient and sparse. During the occasional times of large year-classes the juveniles are easily found in many inshore areas during their second summer. They are typically 20-30 cm in length during their second summer, after which they apparently leave the nearshore bays. One or two years later they begin appearing on the continental shelf and move to their adult distribution as they mature.

Fishery

The major fishery for sablefish in Alaska uses longlines, however sablefish are valuable in the trawl fishery as well. Sablefish enter the longline fishery at 4-5 years of age, perhaps slightly younger in the trawl fishery. The longline fishery takes place primarily in the spring and summer (the regulatory season is between March 15 and November 15). The take of the trawl share of sablefish occurs primarily in association with openings for other species, such as the July rockfish openings, where they are taken as allowed bycatch. Deeper dwelling rockfish, such as Shortraker, Rougheye, and Thornyhead rockfish are the primary bycatch in the longline sablefish fishery. Halibut and rattails (*Albatrossia pectoralis* and *Corphaenoides acrolepis*) also are taken. By regulation, there is no directed trawl fishery for sablefish, however, directed fishing standards have allowed some trawl hauls to target sablefish, where the bycatch is similar to the longline fishery, in addition perhaps to some deep dwelling flatfish.

Relevant Trophic Information

Larval sablefish feed on a variety of small zooplankton ranging from copepod naupli to small amphipods. The epipelagic juveniles feed primarily on macrozooplankton and micronekton (i.e., euphausiids).

The older demersal juveniles and adults appear to be opportunistic feeders, with food ranging from variety of benthic invertebrates, benthic fishes, as well as squid, mesopelagic fishes, jellyfish and fishery discards. Gadid fish (mainly pollock) comprise a large part of the sablefish diet. Nearshore residence during their second year provide the opportunity to feed on salmon fry and smolts during the summer months.

Young of the year sablefish are commonly found in the stomachs of salmon taken in the southeast (SE) troll fishery during the late summer.

What is the approximate upper size limit of juvenile fish (in cm)?

Size of 50% maturity: Bering Sea: males 65 cm, females 67 cm; Aleutian Islands: males 61 cm, females 65 cm; Gulf of Alaska: males 57 cm, females 65 cm. At the end of the second summer (~1.5 years old) they are 35-40 cm in length.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Eggs and Larvae:

NMFS, Alaska Fisheries Science Center, FOCI Program, Art Kendall 206-526-4108, NMFS Auke Bay Lab, Bruce Wing 907-789-????

Juveniles:

ADFG groundfish surveys: Jim Blackburn, ADFG, Kodiak AK 907-486-186, Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961

Kendall, A.W. and A.C. Materese. Biology of eggs, larvae, and epipelagic juveniles of sablefish, *Anoplopoma fimbria*, in relation to their potential use in management. Mar. Fish. Rev. 49(1)1-13.

Smith, G.B., G.E. Walters, P.A. Raymore, Jr., and W.A, Hischberger. 1984. Studies of the distribution and abundance of juvenile groundfish in the northwestern Gulf of Alaska, 1980-82: Part I, Three-year comparisons. NOAA Tech. Memo. NMFS F/NWC-59. 100p.

Walters, G.E., G.B. Smith, P.A. Raymore, and W.A. Hirschberger. 1985. Studies of the distribution and abundance of juvenile groundfish in the northwestern Gulf of Alaska, 1980-82: Part II, Biological characteristics in the extended region. NOAA Tech. Memo. NMFS F/NWC-77. 95 p.

Wing, B.L. and D.J. Kamikawa. 1995. Distribution of neustonic sablefish larvae and associated ichthyoplankton in the eastern Gulf of Alaska, May 1990. NOAA Tech. Memo. NMFS-AFSC-53.

Habitat and Biological Associations (if known) Narrative

Egg/Spawning
Larvae
Juveniles
Adults - other than depth, none is noted.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and Zoogeography of common fishes in the Bering Sea and northeasten Pacific. U.S. Dep. Commer., NOAAS Tech. Rept. NMFS 66, 151 p.

Boehlert, G.W., and M.M. Yoklavich. 1985. Larval and juvenile growth of sablefish, *Anoplopoma fimbria*, as determined from otolith increments. Fish. Bull. 83:475-481.

Grover, J.J., and B.L. Olla. 1986. Morphological evidence for starvation and prey size selection of sea-caught larval sablefish, *Anoplopoma fimbria*. Fish. Bull. 84:484-489.

Grover, J.J., and B.L. Olla. 1987. Effects of and El Niño event on the food habits of larval sablefish, *Anoplopoma fimbria*, off Oregon and Washington. Fish. Bull. 85: 71-79.

Grover, J.J., and B.L. Olla. 1990. Food habits of larval sablefish, *Anoplopoma fimbria* from the Bering Sea. Fish Bull. 88:811-814.

Hunter, J.R., B.J. Macewiccz, and C.A. Kimbrell. 1989. Fecundity and other aspects of the reproduction of Sablefish, *Anoplopoma fimbria*, in Central California Waters. Calif. Coop. Fish. Invst. Rep. 30: 61-72.

Kendall, A.W., Jr., and A.C. Matarese. 1984. Biology of eggs, larvae, and epipelagic juveniles of sablefish, *Anoplopoma fimbria*, in relation to their potential use in management. Mar. Fish. Rev. 49(1):1-13.

Mason, J.C. , R.J. Beamish, and G.A. McFralen. 1983. Sexual maturity, fecundity, spawning, and early life history of sablefish (*Anoplopoma fimbria*) off the Pacific coast of Canada. Can. J. Fish. Aquat. Sci. 40:2121-2134.

McFarlane, G.A., and R.J. Beamish. 1992. Climatic influence linking copepod production with strong year-classes in sablefish, *Anoplopoma fimbria*. Can J. Fish. Aquat. Sci. 49:743-753.

Moser, H.G., R.L. Charter, P.E. Smith, N.C.H. Lo., D.A. Ambrose, C.A. Meyer, E.M. Sanknop, and W. Watson. 1994. Early life history of sablefish, *Anoplopoma fimbria*, off Washington, Oregon, and California with application to biomass estimation. Calif. Coop. Oceanic Fish. Invest. Rep. 35:144-159.

Rutecki, T.L. and E.R. Varosi. 1993. Distribution, age, and growth of juvenile sablefish in Southeast Alaska. Paper presented at International Symposium on the Biology and Management of Sablefish. Seattle, Wash. April 1993.

Rutecki, T.L. and E.R. Varosi. 1993. Migrations of Juvenile Sablefish in Southeast Alaska. Paper presented at International Symposium on the Biology and Management of Sablefish. Seattle, Wash. April 1993.

Sasaki, T. 1985. Studies on the sablefish resources in the North Pacific Ocean. Bulletin 22, (1-108), Far Seas Fishery Laboratory. Shimizu, 424, Japan.

Sigler, M.F., E.R. Varosi, and T.R. Rutecki. 1993. Recruitment curve for sablefish in Alaska based on recoveries of fish tagged as juveniles. Paper presented at International Symposium on the Biology and Management of Sablefish. Seattle, Wash. April 1993.

NOAA (National Oceanic and Atmospheric Administration). 1990. Sablefish, *Anoplopoma fimbria*. Pl 3.2.22. *In*: West Coast of North America Coastal and Ocean Zones Strategic Assessment Data Atlas. Invertebrate and Fish Volume. U.S. Dep. Commer. NOAA. OMA/NOS, Ocean Assessment Division, Strategic Assessment Branch.

Wing, B.L. 1985. Salmon Stomach contents from the Alaska Troll Logbook Program, 1977-84. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-91, 41 p.

Wing, B.L. 1997. Distribution of sablefish, *Anoplopoma fimbria*, larvae in the eastern Gulf of Alaska: Neuston-net tows versus oblique tows. *In*: M. Wilkins and M. Saunders (editors), Proc. Int. Sablefish Symp., April 3-4, 1993, p. 13-25.. U.S. Dep. Commer., NOAA Tech. Rep. 130.

Wing, B.L. and D.J. Kamikawa. 1995. Distribution of neustonic sablefish larvae and associated ichthyoplankton in the eastern Gulf of Alaska, May 1990. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-53, 48 p.

Wing, B.L., C. Derrah, and V. O'Connell. 1997. Ichthyoplankton in the eastern Gulf of Alaska, May 1990. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-376, 42 p.

Wolotera, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-1984. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Yang, M-S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990. NOAA Tech. Memo. NMFS-AFSC-22. 150 p.

SPECIES: Bering Sea/Aleutian Islands Sablefish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	14-20 days	NA	late winter-early spring: Dec-Apr	USP, LSP, BSN	P, 200-3000 m	NA	U	
Larvae	up to 3 months	copepod nauplii, small copepodites, etc	spring-summer: Apr-July	MCS, OCS, LSP, BSN	N, neustonic near surface	NA	U	
Early Juveniles	to 3 yrs	small prey fish, sandlance, salmon, herring, etc		OCS, MCS, ICS, during first summer, then obs in BAY, IP, till end of 2nd summer; not obs'd till found on shelf	P when offshore during first summer, then D, SD/SP when inshore	NA when pelagic. The bays where observed were soft bottomed, but not enough obs. to assume typical.	U ? or NA	
Late Juveniles	3-5 yrs	opportunistic: other fish, shellfish, worms, jellyfish, fishery discards	all year	continental slope, and deep shelf gulleys and fjords.	caught with bottom tending gear. presumably D	varies, generally soft bottoms,	U on slope, ? in fjords	
Adults	5 yrs to 35+	opportunistic: other fish, shellfish, worms, jellyfish, fishery discards	apparently year around, spawning movements (if any) are undescribed	continental slope, and deep shelf gulleys and fjords.	caught with bottom tending gear. presumably D	varies, generally soft bottoms,	U on slope, ? in fjords	

Habitat Description for Pacific ocean perch
(Sebastes alutus)

Management Plan and Area(s) Groundfish, BSAI and GOA

Life History and General Distribution

Pacific ocean perch has a wide distribution in the North Pacific from southern California around the Pacific rim to northern Honshu Is., Japan, including the Bering Sea. The species appears to be most abundant in northern British Columbia, the Gulf of Alaska, and the Aleutian Islands. Adults are found primarily offshore along the continental slope in depths 180-420 m. Seasonal differences in depth distribution have been noted by many investigators. In the summer, adults inhabit shallower depths, especially those between 180 and 250 m. In the fall, the fish apparently migrate farther offshore to depths of ~300-420 m. They reside in these deeper depths until about May, when they return to their shallower summer distribution. This seasonal pattern is probably related to summer feeding and winter spawning. Although small numbers of Pacific ocean perch are dispersed throughout their preferred depth range on the continental slope, most of the population occurs in patchy, localized aggregations. At present, the best evidence indicates that Pacific ocean perch is mostly a demersal species. A number of investigators have speculated that there is also a pelagic component to their distribution, especially at night when they may move off-bottom to feed, but hard evidence for this is lacking.

There is much uncertainty about the life history of Pacific ocean perch, although generally more is known than for other rockfish species. The species appears to be viviparous, with internal fertilization and the release of live young. Insemination occurs in the fall, and sperm are retained within the female until fertilization takes place ~2 months later. The eggs develop and hatch internally, and parturition (release of larvae) occurs in April-May. Information on early life history is very sparse, especially for the first year of life. Positive identification of Pacific ocean perch larvae is not possible at present, but the larvae are thought to be pelagic and to drift with the current. Transformation to an adult form and the assumption of a demersal existence may take place within the first year. Small juveniles probably reside inshore in very rocky, high relief areas, and by age 3 begin to migrate to deeper offshore waters of the continental shelf. As they grow, they continue to migrate deeper, eventually reaching the continental slope, where they attain adulthood.

Pacific ocean perch is a very slow growing species, with a low rate of natural mortality (estimated at 0.05), a relatively old age at 50% maturity (10.5 years for females in the Gulf of Alaska), and a very old maximum age of 98 years in Alaska. Despite their viviparous nature, the fish is relatively fecund with number of eggs/female in Alaska ranging from 10,000-300,000, depending upon size of the fish.

Fishery

Pacific ocean perch are caught almost exclusively with bottom trawls. Age at 50% recruitment has been estimated to be between 9 and 10 years in the Gulf of Alaska, and 7.25 years in the Bering Sea/Aleutian Islands. The fishery in the Gulf in recent years has been concentrated in the summer months, especially July, due mostly to management regulations. In the Bering Sea and Aleutian Islands, most of the fish have been caught during the spring in March and April. Reflecting the summer distribution of this species, the fishery in the Gulf is concentrated in a relatively narrow depth band at 190-250 m along the continental slope. Major fishing grounds are at the entrance of large gullies, where the continental slope is more gradual and a greater area of habitat is found at the preferred depth range. The major grounds include Ommaney Trough, Yakutat Canyon, Amatuli Trough, off Portlock and Albatross Banks, Shelikof Trough, off Shumagin Bank, and south of Unimak and Unalaska Is. In the Bering Sea and Aleutian Islands, the major fishing grounds are north of Unimak Pass, in Seguam and Amukta Pass, north of Atka Is., on Petrel Bank, south of Amchitka Island, and along the upper continental slope northwest of the Pribilof Islands.

For NPFMC-managed species, the major bycatch species in the Gulf of Alaska Pacific ocean perch trawl fishery in 1995 included (in descending order by percent): other species of rockfish, arrowtooth flounder, and sablefish. Among the "other species of rockfish," shortraker/rougheye were most common. There is no information available on the bycatch of non-NPFMC-managed species in the Gulf of Alaska fishery, nor any bycatch information at all for the Aleutian Islands and Bering Sea fisheries.

Relevant Trophic Information

All food studies of Pacific ocean perch have shown them to be overwhelmingly planktivorous. Small juveniles eat mostly calanoid copepods, whereas larger juveniles and adults consume euphausiids as their major prey items. Adults, to a much lesser extent, may also eat small shrimp and squids. It has been suggested that Pacific ocean perch and walleye pollock compete for the same euphausiid prey. Consequently, the large removals of Pacific ocean perch by foreign fishermen in the Gulf of Alaska in the 1960s may have allowed walleye pollock stocks to greatly expand in abundance.

Documented predators of adult Pacific ocean perch include Pacific halibut and sablefish, and it is likely that Pacific cod and arrowtooth flounder also prey on Pacific ocean perch. Pelagic juveniles are consumed by salmon, and benthic juveniles are eaten by lingcod and other large demersal fish.

What is the approximate upper size limit of juvenile fish (in cm)?

For Gulf of Alaska: 38 cm for females; unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*. For Aleutian Islands and Bering Sea: unknown for both sexes.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

> Eggs and Larvae: NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory, Bruce Wing, (907) 789-6043; NMFS, Alaska Fisheries Science Center, FOCI program, Art Kendall (206) 526-4108; Canada Dept. of Fisheries and Oceans, Pacific Biological Station, Nanaimo, B.C., Bruce Leaman, (604) 756-7176.
>
> Juveniles: Carlson, H.R. and R.E. Haight. 1976 . Juvenile life of Pacific ocean perch, *Sebastes alutus*, in coastal fiords of southeastern Alaska: Their environment, growth, food habits, and schooling behavior. Trans. Am, Fish. Soc. 105:191-201.

Habitat and Biological Associations (if known) Narrative

> *Egg/Spawning*: Little information is known. Insemination is thought to occur after adults move to deeper offshore waters in the fall. Parturition is reported to occur from 20-30 m off bottom at depths of 360-400 m.
>
> *Larvae*: Little information is known. Earlier information suggested that after parturition, larvae rise quickly to near surface, where they become part of the plankton. More recent data from British Columbia indicates that larvae may remain at depths >175 m for some period of time (perhaps two months), after which they slowly migrate upward in the water column.
>
> *Juveniles*: Again, information is very sparse, especially for younger juveniles. After metamorphosis from the larval stage, juveniles may reside in a pelagic stage for an unknown length of time. They eventually become demersal, and at age 1-3 probably live in very rocky inshore areas. Afterward, they move to progressively deeper waters of the continental shelf.

Older juveniles are often found together with adults at shallower locations of the continental slope in the summer months.

Adults: Commercial fishery data have consistently indicated that adult Pacific ocean perch are found in aggregations over reasonably smooth, trawlable bottom of the continental slope. Generally, they are found in shallower depths (180-250 m) in the summer, and deeper (300-420 m) in the fall, winter, and early spring. In addition, investigators in the 1960s and 1970s speculated that the fish sometimes inhabited the mid-water environment off bottom and also might be found in rough, untrawlable areas. Hard evidence to support these latter two conjectures, however, has been lacking. The best information available at present suggests that adult Pacific ocean perch is mostly a demersal species that prefers a flat, pebbled substrate along the continental slope. More research is needed, however, before definitive conclusions can be drawn as to its habitat preferences.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and northeastern Pacific. U.S. Dep. Commer., NOAA Tech. Rept. NMFS 66, 151 p.

Carlson, H.R., and R.E. Haight. 1976. Juvenile life of Pacific ocean perch, *Sebastes alutus*, in coastal fiords of southeastern Alaska: their environment, growth, food habits, and schooling behavior. Trans. Am. Fish. Soc. 105:191-201.

Carlson, H.R., and R.R. Straty. 1981. Habitat and nursery grounds of Pacific rockfish, *Sebastes* spp., in rocky coastal areas of Southeastern Alaska. Mar. Fish. Rev. 43: 13-19.

Doyle, M.J. 1992. Patterns in distribution and abundance of ichthyoplankton off Washington, Oregon, and Northern California (1980-1987). U.S. Dep. Commer. NOAA NMFS AFSC Processed Rept. 92-14, 344 p.

Gillespie, G.E., R.D. Stanley, and B.M. Leaman. 1992. Early life history of rockfishes in British Columbia; preliminary results of the first year of investigation. Proc. 1992 W. Groundfish Conf. Alderbrook Inn Resort, Union, WA, Jan 27-30, 1992.

Gunderson, D.R. 1971. Reproductive patterns of Pacific ocean perch (*Sebatodes alutus*) off Washington and British Columbia and their relation to bathymetric distribution and seasonal abundance. J. Fish. Res. Bd. Can. 28: 417-425.

Gunderson, D.R., and M.O. Nelson. 1977. Preliminary report on an experimental rockfish survey conducted off Monterey, California and in Queen Charlotte Sound, British Columbia during August-September, 1976. Prepared for Feb. 15-16, 1977, Interagency Rockfish Survey Coordinating Committee Meeting, NWAFC, Seattle, WA. Unpubl. manuscr. 82 p.

Harrison, R.C. 1993. Data report: 1991 bottom trawl survey of the Aleutian Islands area. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-12. 144 p.

Heifetz, J., and D. Ackley. 1997. Bycatch in rockfish fisheries in the Gulf of Alaska. Unpubl. Manuscr. 20 p. (Available from NMFS Auke Bay Laboratory, 11305 Glacier Hwy., Juneau, AK 99801.

Heifetz, J., J.N. Ianelli, and D.M. Clausen. 1996. Slope rockfish. *In* Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, p.229-269. North Pacific Fishery Management Council, 605 W. 4th. Ave., Suite 306, Anchorage, AK 99501-2252.

Ito, D.H. 1982. A cohort analysis of Pacific ocean perch stocks from the Gulf of Alaska and Bering Sea regions. U.S. Dep. Commer., NWAFC Processed Rept. 82-15, 157 p.

Ito, D.H., and J.N. Ianelli. 1996. Pacific ocean perch. *In* Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions, p.331-359. North Pacific Fishery Management Council, 605 W. 4th. Ave., Suite 306, Anchorage, AK 99501-2252.

Kendall, A.W., and W.H. Lenarz. 1986. Status of early life history studies of northeast Pacific rockfishes. Proc. Int. Rockfish Symp. Oct. 1986, Anchorage Alaska; p. 99-117.

Krieger, K.J. 1993. Distribution and abundance of rockfish determined from a submersible and by bottom trawling. Fish. Bull., U.S. 91:87-96.

Martin, M.H. and D.M. Clausen. 1995. Data report: 1993 Gulf of Alaska bottom trawl survey. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-59. 217 p.

Matarese, A.C., A.W. Kendall, Jr., D.M. Blood, and B.M. Vinter. 1989. Laboratory guide to early life history stages of northeast Pacific fishes. U.S. Dep. Commer. NOAA Tech. Rept. NMFS 80, 652 p.

Matthews, K.R., J.R. Candy, L.J. Richards, and C.M. Hand. 1989. Experimental gill net fishing on trawlable and untrawlable areas off northwestern Vancouver Island, from the MV Caledonian, August 15-28, 1989. Can. Manuscr. Rep. Fish. Aquat. Sci. 2046, 78 p.

Mattson, C.R., and B.L. Wing. 1978. Ichthyoplankton composition and plankton volumes from inland coastal waters of southeastern Alaska, April-November 1972. U.S. Dep. Commer., NOAA Tech. Rept. NMFS SSRF-723, 11 p.

Moser, H.G., 1996. SCORPAENIDAE: scorpionfishes and rockfishes. *In*: Moser, H.G., editor. The early stages of fishes in the California Current region, p. 733-795. CalCOFI Atlas No.33. 1505 p.

NOAA (National Oceanic and Atmospheric Administration). 1990. Pacific ocean perch, *Sebastes alutus*. *In*: West coast of North America coastal and ocean zones strategic assessment: data atlas. Invertebrate and fish volume, Plate 3.2.20. U.S. Dep. Commer. NOAA. OMA/NOS, Ocean Assessments Division, Strategic Assessment Branch.

Ronholt, L.L., K. Teshima, and D.W. Kessler. 1994. The groundfish resources of the Aleutian Islands region and southern Bering Sea 1980, 1983, and 1986. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-31. 351 p.

Seeb, L.W. 1993. Biochemical identification of larval rockfishes of the genus *Sebastes*. Final Report Contract #43ABNF001082. U.S. Dept. Commer. NOAA/NMFS NWAFC/RACE Division, Seattle, WA. 28 p.

Seeb, L.W., and A.W. Kendall, Jr. 1991. Allozyme polymorphisms permit the identification of larval and juvenile rockfishes of the genus *Sebastes*. Environmental Biology of Fishes 30:191-201.

Stark, J.W., and D.M. Clausen. 1995. Data report: 1990 Gulf of Alaska bottom trawl survey. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-49. 221 p.

Westrheim, S.J. 1970. Survey of rockfishes, especially Pacific ocean perch, in the northeast Pacific Ocean, 1963-66. J. Fish. Res. Bd. Canada 27: 1781-1809.

Westrheim, S.J. 1975. Reproduction, maturation, and identification of larvae of some *Sebastes* (Scorpaenidae) species in the northeast Pacific Ocean. J. Fish. Res. Board Can. 32: 2399-2411.

Wing, B.L. 1985. Salmon stomach contents from the Alaska troll logbook program, 1977-84. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-91. 41 p.

Wing, B.L., C. Derrah, and V. O'Connell. 1997. Ichthyoplankton in the eastern Gulf of Alaska, May 1990. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-376, 42 p.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-1984. U. S. Dep. Commer., NOAA Tech. Memo. NMFS - AFSC-6, 184 p.

Yang, M-S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

Yang, M-S. 1996. Diets of the important groundfishes in the Aleutian Islands in summer 1991. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-60, 105 p.

SPECIES: Pacific ocean perch

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	Internal incub-tion; ~90 d	NA	Winter	NA	NA	NA	NA	NA
Larvae	U; assumed between 60 and 180 days	U; assumed to be micro-zooplankton	Spring-summer	ICS, MCS, OCS, USP, LSP, BSN	P	NA	U	U
Juveniles	3-6 months to 10 years	Early juv: calanoid copepods; late juv: euphausiids	All year	ICS, MCS, OCS, USP	?P (early juv. only), D	R (<age 3)	U	U
Adults	10-98 years of age	Euphausiids	Insemination (fall); Fertilization, incubation (winter); Larval release (spring); Feeding in shallower depths (summer)	OCS, USP	D, SD	CB, G,?M, ?SM,?MS	U	U

Habitat Description for Other red rockfish
Shortraker Rockfish (*Sebastes borealis*)
Rougheye Rockfish (*Sebastes aleutianus*)
Northern Rockfish (*Sebastes polyspinus)*

Management Plan and Area(s) Groundfish, BSAI and GOA

Life History and General Distribution

Shortraker and rougheye rockfishes are found along the northwest slope of the eastern Bering Sea, throughout the Aleutian Islands and south to Point Conception, California. Both species are semi-demersal and can be found at depths ranging from 25 to 875 m; however, commercial concentrations usually occur at depths from 100 to 500 m. Though relatively little is known about their biology and life history, both species appear to be K-selected with late maturation, slow growth, extreme longevity, and low natural mortality. Shortraker and rougheye rockfish attain maturity relatively late in life, at about 20+ years of age. Both species are among the largest *Sebastes* species in Alaskan waters, attaining sizes of up to 104 cm for shortraker and 96 cm for rougheye rockfish. Shortraker rockfish have been estimated to attain ages in excess of 120 years and rougheye rockfish in excess of 140 years. Natural mortality for both species is low, estimated to be on the order of 0.01 to 0.04.

Fishery

Trawl and longline gear are the primary methods of harvest. Even though both species are found to as far south as Point Conception, California, commercial quantities are primarily harvested from northern Washington throughout Alaskan waters. Depths of commercial harvests usually occur from about 100 to 500 m. Both species are associated with a variety of habitats from soft to rocky habitats along the continental slope, although boulders and sloping terrain appear to be a desirable habitat feature for both species. Trawling in such habitats often requires specialized fishing skills to avoid gear damage and to keep the trawl in the proper fishing configuration. Age at recruitment is uncertain, but is probably on the order of 20+ years for both species. Shortraker and rougheye rockfish are often caught as bycatch in trawl and longline fisheries for sablefish and halibut.

Relevant Trophic Information

Shortraker and rougheye rockfishes prey primarily on shrimps, squids, and myctophids. It is uncertain what are the main predators on both species.

What is the approximate upper size limit of juvenile fish (in cm)

For shortraker rockfish, length at 50% sexual maturity is about 45 cm and about 44 cm for rougheye rockfish

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Larvae: NMFS, Alaska Fisheries Science Center, FOCI program, Art Kendall, 206-526-4108.

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: The timing of reproductive events is apparently protracted. One study indicated that vitellogenesis was present for four to five months and lasted from about July

until late October and November. Parturition apparently occurs mainly in early spring through summer.

Larvae: No information is available regarding the habitats and biological associations of shortraker and rougheye rockfish larvae.

Juveniles: Very little information is available regarding the habitats and biological associations of shortraker and rougheye rockfish juveniles. It is suspected, however, that the juveniles of both species occupy shallower habitats than that of the adults.

Adults: Adults are semi-demersal and can be found at depths ranging from 25 to 875 m. Submersible observations indicate that adults occur over a wide range of habitats. Soft substrates of sand or mud usually had the highest densities; whereas hard substrates of bedrock, cobble or pebble usually had the lowest adult densities. Habitats with steep slopes and frequent boulders were used at a higher rate than habitats with gradual slopes and few boulders.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and Northeastern Pacific. U.S. Dep. Commerc., NOAA Tech. Rept. NMFS 66, 151 p.

Archibald, C. P., W. Shaw, and B. M. Leaman. 1981. Growth and mortality estimates of rockfishes (Scorpaenidae) from B.C. coastal waters, 1977-79. Can. Tech. Rep. Fish. Aquat. Sci. 1048, 57 p.

Chilton, D. E., and R. J. Beamish. 1982. Age determination methods for fishes studied by the Groundfish Program at the Pacific Biological Station. Can. Spec. Publ. Fish. Aquat. Sci. 60, 102 p.

Heifetz, J., J.N. Ianelli, and D.M. Clausen. 1996. Slope rockfish. *In* Stock assessment and fishery evaluation report for the 1997 Gulf of Alaska groundfish fishery, p. 230-270. North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501.

Kramer, D.E., and V.M. O'Connell. 1986. Guide to northeast Pacific rockfishes, Genera *Sebastes* and *Sebastolobus*. Marine Advisory Bulletin No. 25: 1-78. Alaska Sea Grant College Program, University of Alaska.

Krieger, K. 1992. Shortraker rockfish, *Sebastes borealis*, observed from a manned submersible. Mar. Fish. Rev., 54(4): 34-37.

Krieger, K.J. 1993. Distribution and abundance of rockfish determined from a submersible and by bottom trawling. Fish. Bull. 91:87-96.

Krieger, K.J., and D.H. Ito. Unpublished. Distribution and abundance of shortraker rockfish, *Sebastes borealis*, and rougheye rockfish, *Sebastes aleutianus*, determined from a submersible. Unpublished manuscript.

McDermott, S.F. 1994. Reproductive biology of rougheye and shortraker rockfish, *Sebastes aleutianus* and *Sebastes borealis*. Masters Thesis. Univ. Washington, Seattle.76 p.

Sigler, M.F., and H.H. Zenger, Jr. 1994. Relative abundance of Gulf of Alaska sablefish and other groundfish based on the domestic longline survey, 1989. NOAA Tech. Memo. NMFS-AFSC-40.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-84. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Yang, M-S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

Yang, M-S. 1996. Diets of the important groundfishes in the Aleutian Islands in summer 1991. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-60, 105 p.

SPECIES: Shortraker and Rougheye Rockfish

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	U	U	U	U	U	U	

Larvae	U	U	Spawning: Early spring through summer	U	U	U	U	
Early Juveniles	U	U Shrimp & amphipods?	U	U MCS, OCS?	U	U	U	
Late Juveniles								
Adults	15+ yrs of age	Shrimp Squid Myctophids	Year-round?	OCS, USP	SD	M, S, R, SM, CB, MS, G	U	

Habitat Description for Other rockfish
Thornyheads *(Sebastolobus sp.*)
Dusky Rockfish (*Sebastes ciliatus)*

Management Plan and Area(s) Groundfish, BSAI and GOA

Life History and General Distribution

Thornyheads of the northeastern Pacific Ocean are comprised of two species, the shortspine thornyhead (*Sebastolobus alascanus*) and the longspine thornyhead (*S. altivelis*). The longspine thornyhead is not common in the Gulf of Alaska. The shortspine thornyhead is a demersal species which inhabits deep waters from 93 to 1,460 m from the Bering Sea to Baja California. This species is common throughout the Gulf of Alaska, eastern Bering Sea and Aleutian Islands. The population structure of shortspine thornyheads, however, is not well defined. Thornyheads are slow-growing and long-lived with maximum age in excess of 50 years and maximum size greater than 75 cm and 2 kg. Thornyheads spawn buoyant masses of eggs during the late winter and early spring that resemble bilobate "balloons" which float to the surface. Juvenile shortspine thornyheads have a pelagic period of about 14-15 months and settle out at about 22 to 27 mm. Fifty percent of female shortspine thornyheads are sexually mature at about 21 cm and 12-13 years of age.

Fishery

Trawl and longline gear are the primary methods of harvest. The bulk of the fishery occurs in late winter or early spring through the summer. In the past, this species was seldom the target of a directed fishery. Today thornyheads are one of the most valuable of the rockfish species, with most of the domestic harvest exported to Japan. Thornyheads are taken with some frequency in the longline fishery for sablefish and cod and is often part of the bycatch of trawlers concentrating on pollock and Pacific ocean perch.

Relevant Trophic Information

Shortspine thornyheads prey mainly on epibenthic shrimp and fish. Yang (1993, 1996) showed that shrimp were the top prey item for shortspine thornyheads in the Gulf of Alaska; whereas, cottids were the most important prey item in the Aleutian Islands region. Differences in abundance of the main prey between the two areas might be the main reason for the observed diet differences. Predator size might by another reason for the difference since the average shortspine thornyhead in the Aleutian Islands area was larger than that in the Gulf of Alaska (33.4 cm vs 29.7 cm).

What is the approximate upper size limit of juvenile fish (in cm)

Female shortspine thornyheads appear to be mature at about 21-22 cm.

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Larvae: NMFS, Alaska Fisheries Science Center, FOCI program, Art Kendall, 206-526-4108.

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Eggs float in masses of various sizes and shapes. Frequently the masses are bilobed with the lobes 15 cm to 61 cm in length, consisting of hollow conical sheaths containing a single layer of eggs in a gelatinous matrix. The masses are transparent and not readily observed in the daylight. Eggs are 1.2 to 1.4 mm in diameter with a 0.2 mm oil globule. They move freely in the matrix. Complete hatching time is unknown but is probably more than 10 days.

Larvae: Three day-old larvae are about 3 mm long and apparently float to the surface. It is believed that the larvae remain in the water column for about 14-15 months before settling to the bottom.

Juveniles: Very little information is available regarding the habitats and biological associations of juvenile shortspine thornyheads.

Adults: Adults are demersal and can be found at depths ranging from about 90 to 1,500 m. Groundfish species commonly associated with thornyheads include: arrowtooth flounder (*Atheresthes stomias*), Pacific ocean perch (*Sebastes alutus*), sablefish *(Anoplopoma fimbria*), rex sole (*Glyptocephalus zachirus*), Dover sole (*Microstomus pacificus*), shortraker rockfish (*Sebastes borealis*), rougheye rockfish (*Sebastes aleutianus*), and grenadiers (family Macrouridae). Two congeneric thornyhead species, the longspine thornyhead (*Sebastolobus altivelis*) and a species common off of Japan , *S. Macrochir*, are infrequently encountered in the Gulf of Alaska.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and Northeastern Pacific. U.S. Dep. Commer., NOAA Tech. Rept. NMFS 66, 151 p.

Aton, M. 1981. Gulf of Alaska bottomfish and shellfish resources. U.S. Dep. Commer. Tech. Memo. NMFS F/NWC-10, 51 p.

Archibald, C.P., W. Shaw, and B.M. Leaman. 1981. Growth and mortality estimates of rockfishes (Scorpaenidae) from B.C. coastal waters, 1977-79. Can. Tech. Rep. Fish. Aquat. Sci. 1048, 57 p.

Chilton, D.E., and R.J. Beamish. 1982. Age determination methods for fishes studied by the Groundfish Program at the Pacific Biological Station. Can. Spec. Publ. Fish. Aquat. Sci. 60, 102 p.

Heifetz, J., J.N. Ianelli, and D.M. Clausen. 1996. Slope rockfish. *In* Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, p. 230-270. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Ianelli, J.N., D.H. Ito, and M. Martin. 1996. Thornyheads (*Sebastolobus sp*.). *In* Stock Assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, p. 303-330. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Jacobson, L.D. 1993. Thornyheads. *In* Status of living marine resources off the Pacific coast of the United States for 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-26, 35-37 p.

Kramer, D.E., and V.M. O'Connell. 1986. Guide to northeast Pacific rockfishes, Genera *Sebastes* and *Sebastolobus*. Marine Advisory Bulletin No. 25: 1-78. Alaska Sea Grant College Program, University of Alaska.

Low, L.L. 1994. Thornyheads. *In* Status of living marine resources off Alaska, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-27, 56-57 p.

Sigler, M.F., and H.H. Zenger, Jr. 1994. Relative abundance of Gulf of Alaska sablefish and other groundfish based on the domestic longline survey, 1989. NOAA Tech. Memo. NMFS-AFSC-40.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-84. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Yang, M-S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

Yang, M-S. 1996. Diets of the important groundfishes in the Aleutian Islands in summer 1991. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-60, 105 p.

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	U	Spawning: Late winter and early spring	U	P	U	U	
Larvae	<15 Months	U	Early spring through summer	U	P	U	U	
Juveniles	> 15 months when settling to bottom occurs (?)	U Shrimp, Amphipods, Mysids, Euphausiids?	U	MCS, OCS, USP	D	M, S, R, SM, CB, MS, G	U	
Adults	U	Shrimp Fish (cottids), Small crabs	Year-round?	MCS, OCS, USP, LSP	D	M, S, R, SM, CB, MS, G	U	

Habitat Description for Atka mackerel
Pleurogrammus monopterygius

Management Plan and Area(s) Groundfish, BSAI and GOA

Life History and General Distribution

Distributed from the Gulf of Alaska to the Kamchatka Peninsula, most abundant along the Aleutians. Adult Atka mackerel occur in large localized aggregations usually at depths less than 200 m and generally over rough, rocky and uneven bottom near areas where tidal currents are swift. Adults are pelagic during much of the year, but migrate annually to moderately shallow waters where they become demersal during spawning. Spawning peaks in June through September, but may occur intermittently throughout the year. Atka mackerel deposit eggs in nests built and guarded by males on rocky substrates or on kelp in shallow water. Eggs hatch in 40-45 days, releasing planktonic larvae which have been found up to 800 km from shore. Little is known of the distribution of young Atka mackerel prior to their appearance in trawl surveys and the fishery at about age 2-3 years. Atka mackerel exhibit intermediate life history traits. R-traits include young age at maturity (approximately 50% are mature at age 3), fast growth rates, high natural mortality (M=0.3) and young average and maximum ages (about 5 and 14 years, respectively). K-selected traits include low fecundity (only about 30,000 eggs/female/year, large egg diameters (1-2 mm) and male nest-guarding behavior).

Fishery

Bottom trawls, some pelagic trawling, recruit at about age 3, conducted in the Aleutian Islands and western GOA at depths between about 70-225 m, in trawlable areas on rocky, uneven bottom, along edges, and in lee of submerged hills during periods of high current. Currently, the fishery occurs on reefs west of Kiska Island, south and west of Amchitka Island, in Tanaga Pass and near the Delarof Islands, and south of Seguam and Umnak Islands. Historically fishery occurred east into the GOA as far as Kodiak Island (through the mid-1980s), but is no longer there. Fishery used to be entirely during summer, during spawning season; now occurs throughout the year. Very "clean" fishery; bycatch of other species is minimal.

Relevant Trophic Information

Important food for Steller sea lions in the Aleutian Islands, particularly during summer, and for other marine mammals (minke whales, Dall's porpoise and northern fur seal). Juveniles eaten by thick billed murres and tufted puffins. Main groundfish predators are Pacific halibut, arrowtooth flounder, and Pacific cod.

What is the approximate upper size limit of juvenile fish (in cm)? 35 cm

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Larvae: NMFS, Alaska Fishery Science Center, FOCI program, Rick Brodeur 206-526-4318
Juveniles: NMFS, Alaska Fishery Science Center, NMML, Richard Merrick 206-526-6173

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Eggs deposited in nests built and guarded by males on rocky substrates or on kelp in shallow water.

Larvae/Juveniles: Planktonic larvae have been found up to 800 km from shore, usually in upper water column (neuston), but little is known of the distribution of Atka mackerel until they are about 2 years old and appear in fishery and surveys.

Adults: Adults occur in localized aggregations usually at depths less than 200 m and generally over rough, rocky and uneven bottom near areas where tidal currents are swift. Adults are semi-demersal/pelagic during much of the year, but migrate annually to moderately shallow waters where the males become demersal during spawning; females move between nesting and offshore feeding areas.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and Northeastern Pacific. U.S. Dep. Commerc., NOAA Tech. Rept. NMFS 66, 151 p.

Byrd, G.V., J.C. Williams, and R. Walder. 1992. Status and biology of the tufted puffin in the Aleutian Islands, Alaska, after a ban on salmon driftnets. U.S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge, Aleutian Islands Unit, PSC 486, Box 5251, FPO AP 96506-5251, Adak, Alaska.

Doyle, M.J., W.C. Rugen, and R.D. Brodeur. 1995. Neustonic ichthyoplankton in the western Gulf of Alaska during spring. Fishery Bulletin 93: 231-253.

Fritz, L.W. 1993. Trawl locations of walleye pollock and Atka mackerel fisheries in the Bering Sea, Aleutian Islands, and Gulf of Alaska from 1977-1992. AFSC Processed Report 93-08, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 162 pp.

Gorbunova, N.N. 1962. Razmnozhenie I razvite ryb semeistva terpugovykh (Hexagrammidae) Spawning and development of greenlings (family Hexagrammidae). Tr. Inst. Okeanol., Akad. Nauk SSSR 59:118-182. In Russian. (Trans. by Isr. Program Sci. Trans., 1970, p. 121-185 in T.S. Rass (editor), Greenlings: taxonomy, biology, interoceanic transplantation; available from the U.S. Dep. Commer., Natl. Tech. Inf. Serv., Springfield, VA., as TT 69-55097).

Kajimura, H. 1984. Opportunistic feeding of the northern fur seal Callorhinus ursinus, in the eastern north Pacific Ocean and eastern Bering Sea. NOAA Tech. Rept. NMFS SSRF-779. USDOC, NOAA, NMFS, 49 pp.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. U.S. Dep. Commerc., NOAA Tech. Rept NMFS 20, 89 p.

Kendall, A.W., Jr., J.R. Dunn, and R.J. Wolotira, Jr. 1980. Zooplankton, including ichthyoplankton and decapod larvae, of the Kodiak shelf. NWAFC Processed Rept. 80-8, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 393 p.

Lee, J.U. 1985. Studies on the fishery biology of the Atka mackerel *Pleurogrammus monopterygius* (Pallas) in the north Pacific Ocean. Bull. Fish. Res. Dev. Agency, 34, pp.65-125.

Levada, T.P. 1979. Comparative morphological study of Atka mackerel. Pac. Sci. Res. Inst. Fish. Oceanogr. (TINRO), Vladivostok, U.S.S.R., Unpublished manuscript.

Levada, T.P. 1979. Some data on biology and catch of Atka mackerel. Pac. Sci. Res. Inst. Fish. Oceanogr. (TINRO), Vladivostok, U.S.S.R., Unpublished manuscript.

Lowe, S.A. and L.W. Fritz. 1996. Atka mackerel. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Lowe, S.A. and L.W. Fritz. 1996. Atka mackerel. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

McDermott, S.F. and S.A. Lowe. 1997. The reproductive cycle and sexual maturity of Atka mackerel (*Pleurogrammus monopterygius*) in Alaskan waters. Fishery Bulletin 95: 321-333.

Morris, B.F. 1981. An assessment of the living marine resources of the central Bering Sea and potential resource use conflicts between commercial fisheries and Petroleum development in the Navarin Basin, Proposed sale No. 83. Anchorage, AK: USDOC, NOAA, NMFS, Environmental Assessment Division.

Musienko, L.N. 1970. Razmnozheine I razvitie ryb Beringova morya (Reproduction and development of Bering Sea fishes). Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Koz. Okeanogr. 70: 161-224 In P.A. Moiseev (ed.), Soviet fisheries investigations in the northeastern Pacific, Pt. 5, Avail. Natl. Tech. Info. Serv., Springfield, VA as TT 74-50127.

NMFS. 1995. Status review of the Unites States Steller sea lion (*Eumetopias jubatus*) population. National Marine Mammal Laboratory, Alaska Fishery Science Center, National Marine Fisheries Service, 7600 Sand Point Way, NE, Seattle, WA 98115.

Orlov, A.M. 1996. The role of mesopelagic fishes in feeding of Atka mackerel in areas of the North Kuril islands. Publ. Abstract in Role of forage fishes in marine ecosystems. Symposium held Nov 1996, AK Sea Grant, U. Alaska, Fairbanks.

Rugen, W.C. 1990. Spatial and temporal distribution of larval fish in the western Gulf of Alaska, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*) larvae. NWAFC Processed Rept 90-01, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 162 p.

Waldron, K.D. 1978. Ichthyoplankton of the eastern Bering Sea, 11 February-16 March 1978. REFM Report, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 33 p.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the eastern Bering Sea. Final Report (RU 380), Environmental Assessment of the Alaskan continental shelf, REFM, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 88 p.

Wolotira, R.J., Jr., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-84. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-6, 184 p.

Yang, M-S. 1996. Trophic role of Atka mackerel in the Aleutian Islands. Publ. Abstract in Role of forage fishes in marine ecosystems. Symposium held Nov 1996, AK Sea Grant, U. Alaska, Fairbanks.

Zolotov, O.G. 1993. Notes on the reproductive biology of *Pleurogrammus monopterygius* in Kamchatkan waters. J. of Ichthy. 33(4), pp. 25-37.

SPECIES: Atka mackerel

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	40-45 d	NA	summer	IP, ICS	D	GR, R, K	U	develop 3-20°C optimum 9-13°C
Larvae	up to 6 mos	U copepods?	fall-winter	U	U N?	U	U	2-12°C optimum 5-7°C
Juveniles	½-2 yrs of age	U copepods & euphausiids?	all year	U	U	U	U	3-5°C
Adults	3+ yrs of age	copepods euphausiids meso-pelagic fish (myctophids)	spawning (May-Oct) non-spawning (Nov-Apr) tidal/diurnal, year-round?	ICS and MCS, IP MCS and OCS, IP ICS, MCS, OCS, IP	D (males) SD females SD/D all sexes D when currents high/day SD slack tides/night	GR, R, K	F, E	3-5°C all stages >17 ppt only

Habitat Description for Squid
(*Cephalopoda, Teuthida*)

Management Plan and Area(s): BSAI & GOA groundfish

Species Representatives:

Gonaditae: Red or magistrate armhook squid (*Berryteuthis magister*)
Onychoteuthidae:
Boreal clubhook squid (*Onychoteuthis banksii borealjaponicus)*
Giant or robust clubhook squid (*Moroteuthis robusta*)
Sepiolidae: eastern Pacific bobtail squid (*Rossia pacifica*)

Life History and General Distribution:

Squid are members of the molluscan class Cephalopoda, along with octopus, cuttlefish and nautiloids. In the BSAI and GOA, gonatid and onychoteuthid squids are generally the most common, along with chiroteuthids. All cephalopods are stenohaline, occurring only at salinities > 30 ppt. Fertilization is internal, and development is direct ("larval" stages are only small versions of adults). The eggs of inshore neritic species are often enveloped in a gelatinous matrix attached to rocks, shells or other hard substrates, while the eggs of some offshore oceanic species are extruded as large, sausage-shaped drifting masses. Little is known of the seasonality of reproduction, but most species probably breed in spring-early summer, with eggs hatching during the summer. Most small squid are generally thought to live only 2-3 years, but the giant *Moroteuthis robusta* clearly lives longer.

B magister is widely distributed in the boreal north Pacific from California, throughout the Bering Sea, to Japan in waters of depth 30-1500 m; adults most often found at mesopelagic depths or near bottom on shelf, rising to the surface at night; juveniles are widely distributed across shelf, slope and abyssal waters in meso- and epipelagic zones, and rise to surface at night. Migrates seasonally, moving northward and inshore in summer, and southward and offshore in winter, particularly in the western north Pacific. Maximum size: females-50 cm mantle length (ML); males-40 cm ML. Spermatophores transferred into the mantle cavity of female, and eggs are laid on the bottom on the upper slope (200-800 m). Fecundity estimated at 10,000 eggs/female. Spawning of eggs occurs in Feb-Mar in Japan, but apparently all year-round in the Bering Sea. Eggs hatch after 1-2 months of incubation; development is direct. Adults are gregarious prior to, and most die after mating.

O. banksii borealjaponicus, an active, epipelagic species, is distributed in the north Pacific from the Sea of Japan, throughout the Aleutian Islands and south to California, but is absent from the Sea of Okhotsk and not common in the Bering Sea. Juveniles can be found over shelf waters at all depths and near shore. Adults apparently prefer the upper layers over slope and abyssal waters; diel migrators and gregarious. Development includes a larval stage; maximum size about 55 cm.

M. robusta, a giant squid, lives near the bottom on the slope, and mesopelagically over abyssal waters; rare on the shelf. It is distributed in all oceans, and is found in the Bering Sea, Aleutian Islands and Gulf of Alaska. Mantle length can be up to 2.5 m long; with tentacles, at least 7 m, but most are about 2 m long.

R. pacifica is a small (maximum length with tentacles of less than 20 cm) demersal, neritic and shelf, boreal species, distributed from Japan to California in the North Pacific and in the Bering Sea in waters of about 20-300 m depth. Other *Rossia* spp. deposit demersal egg masses.

Fishery:

Not currently a target of groundfish fisheries of BSAI or GOA. A Japanese fishery catching up to 9,000 mt of squid annually existed until the early 1980s for *B. magister* in the Bering Sea and *O. banksii borealjaponicus* in the Aleutian Islands. Since 1990, annual squid bycatch has been about 1,000 mt or less in the BSAI, and between 30-150 mt in the GOA; in the BSAI, almost all squid bycatch is in the midwater pollock fishery near the continental shelf break and slope, while in the GOA, trawl fisheries for rockfish and pollock (again mostly near the edge of the shelf and on the upper slope) catch most of the squid bycatch.

Relevant Trophic Information

The principal prey items of squid are small forage fish pelagic crustaceans (e.g., euphausiids and shrimp), and other cephalopods; cannibalism is not uncommon. After hatching, small planktonic zooplankton (copepods) are eaten. Squid are preyed upon by marine mammals, seabirds, and, to a lesser extent by fish, and occupy an important role in marine food webs worldwide. Perez (1990) estimated that squids comprise over 80% of the diets of sperm whales, bottlenose whales and beaked whales, and about half of the diet of Dall's porpoise in the eastern Bering Sea and Aleutian Islands. Seabirds (e.g., kittiwakes, puffins, murres) on island rookeries close to the shelf break (e.g., Buldir Island, Pribilof Islands) are also known to feed heavily on squid (Hatch et al. 1990; Byrd et al. 1992; Springer 1993). In the Gulf of Alaska, only about 5% or less of the diets of most groundfish consisted of squid (Yang 1993). However, squid play a larger role in the diet of salmon (Livingston and Goiney 1983).

What is the approximate upper size limit of juvenile fish (in cm)?

For *B. magister*, approx. 20 cm ML for males, 25 cm ML for females; both at approximately 1 year of age.

Additional source of information

Beth Sinclair, NMFS, Seattle, WA 206-526-6466

Habitat Narrative for *B. magister*:

Egg/Spawning: Eggs are laid on the bottom on the upper slope (200-800 m); incubate for 1-2 months.

Young Juveniles: Distributed epipelagically (top 100 m) from the coast to open ocean.

Old Juveniles and Adults: Distributed mesopelagically (most from 150-500 m) on the shelf (summer only?), but mostly in outer shelf/slope waters (to lesser extent over the open ocean). Migrate to slope waters to mate and spawn demersally.

Literature

Arkhipkin, A.I., V.A. Bizikov, V.V. Krylov, and K.N. Nesis. 1996. Distribution, stock structure, and growth of the squid *Berryteuthis magister* (Berry, 1913) (Cephalopoda, Gonatidae) during summer and fall in the western Bering Sea. Fish. Bull. 94: 1-30.

Akimushkin, I.I. 1963. Cephalopods of the seas of the U.S.S.R. Academy of Sciences of the U.S.S.R., Institute of Oceanology, Moscow. Translated from Russian by Israel Program for Scientific Translations, Jerusalem 1965. 223 p.

Byrd, G.V., J.C. Williams, and R. Walder. 1992. Status and biology of the tufted puffin in the Aleutian Islands, Alaska, after a ban on salmon driftnets. U. S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge, Aleutian Islands Unit, PSC 486, Box 5251, FPO AP 96506-5251, Adak, Alaska.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK.

Hatch, S.A., G.V. Byrd, D.B. Irons, and G.L. Hunt, Jr. 1990. Status and ecology of kittiwakes in the North Pacific. Proc. Pacific Seabird Group Symposium, Victoria, B.C., 21-25 February 1990.

Livingston, P.A., and B.J. Goiney, Jr. 1983. Food habits literature of North Pacific marine fishes: a review and selected bibliography. U.S. Dep. Commerc., NOAA Tech. Memo. NMFS F/NWC-54, 81 p.

Nesis, K. N. 1987. Cephalopods of the world. TFH Publications, Neptune City, NJ, USA. 351 pp.

Perez, M. 1990. Review of marine mammal population and prey information for Bering Sea ecosystem studies. U.S. Dep. Commerc., NOAA Tech. Memo. NMFS F/NWC-186, 81 p.

Sobolevsky, Ye. I. 1996. Species composition and distribution of squids in the western Bering Sea. Pp. 135-141 *In* O.A. Mathisen and K.O. Coyle (eds.), Ecology of the Bering Sea: a review of Russian literature. Alaska Sea Grant Rept 96-01, U. Alaska, Fairbanks, AK 99775.

Springer, A. 1993. Report of the seabird working group. pp. 14-29 *In* Is it food? Addressing marine mammal and seabird declines: a workshop summary. Alaska Sea Grant Report 93-01, Univ. Alaska, Fairbanks, AK, 99775.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990. U.S. Dep. Commerc., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

SPECIES: *Berryteuthis magister* (red squid)

Stage - EFH Level	**Duration or Age**	**Diet/Prey**	**Season-Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs	1-2 months	NA	varies	USP, LSP	D	M, SM, MS	U	
Young juveniles	4-6 months	zooplankton		All shelf, slope, BSN	P, N	NA	UP, F?	
Older Juveniles and Adults	1-2 years (may be up to 4 yrs)	euphausiids, shrimp, small forage fish, and other cephalopods	summer winter	All shelf, USP, LSP, BSN OS, USP, LSP, BSN	SP SP	U U	UP, F? UP, F?	Euhaline waters, 2-4°C

Habitat Description for Other Species Complex
Capelin (*osmeridae*)

Management Plan and Area(s): BSAI & GOA groundfish

Species Representative:
Capelin (*Mallotus villosus*)

Life History and General Distribution

Capelin is a short-lived marine (neritic), pelagic, filter-feeding schooling fish distributed along the entire coastline of Alaska and the Bering Sea, and south along British Columbia to the Strait of Juan de Fuca; circumpolar. In the N. Pacific, capelin grow to a maximum of 25 cm and 5 years of age. Spawn at ages 2-4 in spring and summer (May-Aug; earlier in south, later in north) when about 11-17 cm on coarse sand, fine gravel beaches, especially in Norton Sound, northern Bristol Bay, along the Alaska Peninsula and near Kodiak. Age at 50% maturity=2 years. Fecundity: 10,000-15,000 eggs per female. Eggs hatch in 2-3 weeks. Most capelin (60-70%) die after spawning. Larvae and juveniles are distributed on inner-mid shelf in summer (rarely found in waters deeper than about 200 m), and juveniles and adults congregate in fall in mid-shelf waters east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands, and north into the Gulf of Anadyr. Distributed along outer shelf and under ice edge in winter. Larvae, juveniles and adults have diurnal vertical migrations following scattering layers - night near surface, at depth during the day. Smelts are captured during trawl surveys, but their patchy distribution both in space and time reduces the validity of biomass estimates.

Fishery:

Not a target species in groundfish fisheries of BSAI or GOA, but caught as bycatch (up to several hundred tons per year in the 1990s) principally by yellowfin sole trawl fishery in Kuskokwim and Togiak Bays in spring in BSAI; almost all discarded. Small local coastal fisheries occur in spring and summer.

Relevant Trophic Information

Capelin are important prey for marine birds and mammals as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance and juvenile pollock (Hunt et al. 1981a; Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise, and fin, sei, humpback, beluga whales) feed on smelts, which may provide an important seasonal food source near the ice-edge in winter, and as they assemble nearshore in spring to spawn (Frost and Lowry 1987; Wespestad 1987). Smelts also comprise significant portions of the diets of some commercially exploited fish species, such as Pacific cod, walleye pollock, arrowtooth flounder, Pacific halibut, sablefish, Greenland turbot and salmon, throughout the North Pacific Ocean and the Bering Sea (Allen 1987; Yang 1993; Livingston, in prep.).

What is the approximate upper size limit of juvenile fish (in cm)? 13 cm

Provide source (agency, name and phone number, or literature reference) for any possible additional distribution data (do not include AFSC groundfish surveys or fishery observer data)

Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961
Jim Blackburn, ADFG, Kodiak AK 907-486-1861

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Spawn adhesive eggs (about 1 mm in diameter) on fine gravel or coarse sand (0.5-1 mm grain size) beaches intertidally to depths of up to 10 m in May-July in Alaska (later to the north in Norton Sound). Hatching occurs in 2-3 weeks. Most intense spawning when coastal water temperatures are 5-9°C.

Larvae: After hatching, 4-5 mm larvae remain on the middle-inner shelf in summer; distributed pelagically; centers of distribution are unknown, but have been found in high concentrations north of Unimak Island, in the western GOA, and around Kodiak Island.

Juveniles: In fall, juveniles are distributed pelagically in mid-shelf waters (50-100 m depth; -2-3°C), and have been found in highest concentrations east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands and north into the Gulf of Anadyr.

Adults: Found in pelagic schools in inner-mid shelf in spring-fall, feed along semi-permanent fronts separating inner, mid, and outer shelf regions (~50 and 100 m). In winter, found in concentrations under ice-edge and along mid-outer shelf.

Literature

Allen, M.J. 1987. Demersal fish predators of pelagic forage fishes in the southeastern Bering Sea. Pp. 29-32 In Forage fishes of the southeastern Bering Sea. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and Northeastern Pacific. U.S. Dep. Commerc., NOAA Tech. Rept. NMFS 66, 151 p.

Crawford, T.W. 1981. Vertebrate prey of *Phocoenoides dalli* (Dall's porpoise), associated with the Japanese high seas salmon fishery in the North Pacific Ocean. M.S. Thesis, Univ. Washington, Seattle, 72 p.

Doyle, M.J., W.C. Rugen, and R.D. Brodeur. 1995. Neustonic ichthyoplankton in the western Gulf of Alaska during spring. Fishery Bulletin 93: 231-253.

Eschmyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes, North America. Houghton Mifflin Co., Boston. 336 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Fritz, L.W., V.G. Wespestad, and J.S. Collie. 1993. Distribution and abundance trends of forage fishes in the Bering Sea and Gulf of Alaska. Pp. 30-44 *In* Is It Food: Addressing marine mammal and seabird declines. Workshop Summary. Alaska Sea Grant College Program Rept. No. AK-SG-93-01, Univ. Alaska, Fairbanks, AK 99775-5040.

Frost, K.J. and L. Lowry. 1987. Marine mammals and forage fishes in the southeastern Bering Sea. Pp. 11-18 In Forage fishes of the southeastern Bering Sea. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

Hunt, G.L., Jr., B. Burgeson, and G.A. Sanger. 1981a. Feeding ecology of seabirds of the eastern Bering Sea. Pp 629-647 *In* D.W. Hood and J.A. Calder (eds.), The Eastern Bering Sea Shelf: Oceanography and Resources, Vol. II. U.S. Dept. Commerc., NOAA, OCSEAP, Office of Marine Pollution Assessment, Univ. WA Press, Seattle, WA.

Hunt, G.L., Jr., Z. Eppley, B. Burgeson, and R. Squibb. 1981b. Reproductive ecology, foods and foraging areas of seabirds nesting on the Pribilof Islands, 1975-79. Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators, RU-83, U.S. Dept. Commerc., NOAA, OCSEAP, Boulder, CO.

Kawakami, T. 1980. A review of sperm whale food. Sci. Rep. Whales Res. Inst. Tokyo 32: 199-218.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. U.S. Dep. Commerc., NOAA Tech. Rept NMFS 20, 89 p.

Kendall, A.W., Jr., J.R. Dunn, and R.J. Wolotira, Jr. 1980. Zooplankton, including ichthyoplankton and decapod larvae, of the Kodiak shelf. NWAFC Processed Rept. 80-8, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 393 p.

Livingston, P.A. Groundfish utilization of walleye pollock (*Theragra chalcogramma*), Pacific herring (*Clupea pallasi*) and capelin (*Mallotus villosus*) resources in the Gulf of Alaska. In preparation.

Morris, B.F., M.S. Alton, and H.W. Braham. 1983. Living marine resources of the Gulf of Alaska: a resource assessment for the Gulf of Alaska/Cook Inlet Proposed Oil and Gas Lease Sale 88. U.S. Dept. Commerc., NOAA, NMFS.

Murphy, E.C., R.H. Day, K.L. Oakley, A.A. Hoover. 1984. Dietary changes and poor reproductive performances in glaucous-winged gulls. Auk 101: 532-541.

Naumenko, E.A. 1996. Distribution, biological condition, and abundance of capelin (*Mallotus villosus socialsis)* in the Bering Sea. Pp. 237-256 *In* O.A. Mathisen and K.O. Coyle (eds.), Ecology of the Bering Sea: a review of Russian literature. Alaska Sea Grant Report No. 96-01, Alaska Sea Grant College Program, U. Alaska, Fairbanks, AK 99775-5040. 306 p.

Pahlke, K.A. 1985. Preliminary studies of capelin Mallotus villosus in Alaska waters. Alaska Dept. Fish Game, Info. Leaf. 250, 64 p.

Perez, M.A. and M.A. Bigg. 1986. Diet of northern fur seals, *Callorhinus ursinus*, off western North America. Fish. Bull., U.S. 84: 957-971.

Pitcher, K.W. 1980. Food of the harbor seal, *Phoca vitulina richardsi*, in the Gulf of Alaska. Fish. Bull., U.S. 78: 544-549.

Rugen, W.C. 1990. Spatial and temporal distribution of larval fish in the western Gulf of Alaska, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*) larvae. NWAFC Processed Rept 90-01, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 162 p.

Waldron, K.D. 1978. Ichthyoplankton of the eastern Bering Sea, 11 February-16 March 1978. REFM Report, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 33 p.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the eastern Bering Sea. Final Report (RU 380), Environmental Assessment of the Alaskan continental shelf, REFM, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 88 p.

Wespestad, V.G. 1987. Population dynamics of Pacific herring (*Clupea palasii*), capelin (*Mallotus villosus*), and other coastal pelagic fishes in the eastern Bering Sea. Pp. 55-60 *In* Forage fishes of the southeastern Bering Sea. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990. U.S. Dept. Commerc., NOAA Tech. Memo. NMFS-AFSC-22. 150 pp.

SPECIES: CAPELIN

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	2-3 weeks to hatch	na	May-August	BCH (to 10 m)	D	S, CB		5-9°C peak spawning
Larvae	4-8 months?	Copepods phytoplankton	summer/fall/ winter	ICS, MCS	N, P	U NA?	U	
Juveniles	1.5+ yrs up to age 2	Copepods Euphausiids	all year	ICS, MCS	P	U NA?	U F? Ice edge in winter	
Adults	2 yrs ages 2-4+	Copepods Euphausiids polychaetes small fish	spawning (May-August) non-spawning (Sep-Apr)	BCH (to 10 m) ICS, MCS, OCS	D, SD P	S, CB NA?	F Ice edge in winter	-2 - 3°C Peak distributions in BS?

Habitat Description for Other Species Complex
Eulachon (*osmeridae*)

Management Plan and Area(s): BSAI & GOA groundfish

Species Representative:

Eulachon, candlefish *(Thaleichthys pacificus*)

Life History and General Distribution:

Eulachon is a short-lived anadromous, pelagic schooling fish distributed from the Pribilof Islands in the eastern Bering Sea, throughout the Gulf of Alaska, and south to California. Consistently found pelagically in Shelikof Strait (hydroacoustic surveys in late winter-spring) and between Unimak Island and the Pribilof Islands (bycatch in groundfish trawl fisheries) from the middle shelf to over the slope. In the North Pacific, eulachon grow to a maximum of 23 cm and 5 years of age. Spawn at ages 3-5 in spring and early summer (April-June) when about 14-20 cm in rivers on coarse sandy bottom. Age at 50% maturity=3 years. Fecundity: ~25,000 eggs per female. Eggs adhere to sand grains and other substrates on river bottom. Eggs hatch in 30-40 days in BC at 4-7°C. Most eulachon die after first spawning. Larvae drift out of rivers and develop at sea. Smelts are captured during trawl surveys, but their patchy distribution both in space and time reduces the validity of biomass estimates.

Fishery:

Not a target species in groundfish fisheries of BSAI or GOA, but caught as bycatch (up to several hundred tons per year in the 1990s) principally by midwater pollock fisheries in Shelikof Strait (GOA), on the east side of Kodiak (GOA), and between the Pribilof Islands and Unimak Island on the outer continental shelf and slope (EBS); almost all discarded. Small local coastal fisheries occur in spring and summer.

Relevant Trophic Information

Eulachon may be important prey for marine birds and mammals as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance and juvenile pollock (Hunt et al. 1981a; Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise, and fin, sei, humpback, beluga whales) feed on smelts, which may provide an important seasonal food source near the ice-edge in winter, and as they assemble nearshore in spring to spawn (Frost and Lowry 1987; Wespestad 1987). Smelts also comprise significant portions of the diets of some commercially exploited fish species, such as Pacific cod, walleye pollock, arrowtooth flounder, Pacific halibut, sablefish, Greenland turbot and salmon, throughout the North Pacific Ocean and the Bering Sea (Allen 1987; Yang 1993; Livingston, in prep.).

What is the approximate upper size limit of juvenile fish (in cm)? 14 cm

Source of Additional Data

Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961
Jim Blackburn, ADFG, Kodiak AK 907-486-1861

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Anadromous; return to spawn in spring (May-June) in rivers; demersal eggs adhere to bottom substrate (sand, cobble, etc.). Hatching occurs in 30-40 days.

Larvae: After hatching, 5-7 mm larvae drift out of river and develop pelagically in coastal marine waters; centers of distribution are unknown.

Juveniles and Adults: Distributed pelagically in mid-shelf to upper slope waters (50-1000 m water depth), and have been found in highest concentrations between the Pribilof Islands and Unimak Island on the outer shelf, and in Shelikof east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands and north into the Gulf of Anadyr.

Literature

Allen, M.J. 1987. Demersal fish predators of pelagic forage fishes in the southeastern Bering Sea. Pp. 29-32 *In* Forage fishes of the southeastern Bering Sea. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Crawford, T.W. 1981. Vertebrate prey of *Phocoenoides dalli* (Dall's porpoise), associated with the Japanese hign seas salmon fishery in the North Pacific Ocean. M.S. Thesis, Univ. Washington, Seattle, 72 p.

Fritz, L.W., V.G. Wespestad, and J.S. Collie. 1993. Distribution and abundance trends of forage fishes in the Bering Sea and Gulf of Alaska. Pp. 30-44 *In* Is It Food: Addressing marine mammal and seabird declines. Workshop Summary. Alaska Sea Grant College Program Rept. No. AK-SG-93-01, Univ. Alaska, Fairbanks, AK 99775-5040.

Frost, K.J. and L. Lowry. 1987. Marine mammals and forage fishes in the southeastern Bering Sea. Pp. 11-18 *In* Forage fishes of the southeastern Bering Sea. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

Hunt, G.L., Jr., B. Burgeson, and G.A. Sanger. 1981a. Feeding ecology of seabirds of the eastern Bering Sea. Pp 629-647 *In* D.W. Hood and J.A. Calder (eds.), The Eastern Bering Sea Shelf: Oceanography and Resources, Vol. II. U.S. Dept. Commerc., NOAA, OCSEAP, Office of Marine Pollution Assessment, Univ. WA Press, Seattle, WA.

Hunt, G.L., Jr., Z. Eppley, B. Burgeson, and R. Squibb. 1981b. Reproductive ecology, foods and foraging areas of seabirds nesting on the Pribilof Islands, 1975-79. Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators, RU-83, U.S. Dept. Commerc., NOAA, OCSEAP, Boulder, CO.

Kawakami, T. 1980. A review of sperm whale food. Sci. Rep. Whales Res. Inst. Tokyo 32: 199-218.

Livingston, P.A. Groundfish utilization of walleye pollock (*Theragra chalcogramma*), Pacific herring (*Clupea pallasi*) and capelin (*Mallotus villosus*) resources in the Gulf of Alaska. In preparation.

Morris, B.F., M.S. Alton, and H.W. Braham. 1983. Living marine resources of the Gulf of Alaska: a resource assessment for the Gulf of Alaska/Cook Inlet Proposed Oil and Gas Lease Sale 88. U.S. Dept. Commerc., NOAA, NMFS.

Perez, M.A. and M.A. Bigg. 1986. Diet of northern fur seals, *Callorhinus ursinus*, off western North America. Fish. Bull., U.S. 84: 957-971.

Pitcher, K.W. 1980. Food of the harbor seal, *Phoca vitulina richardsi*, in the Gulf of Alaska. Fish. Bull., U.S. 78: 544-549.

Sanger, G.A. 1983. Diets and food web relationships of seabirds in the Gulf of Alaska and adjacent marine regions. Outer Continental Shelf Environmental Assessment Program, Final Reports of Principal Investigators 45: 631-771.

Wespestad, V.G. 1987. Population dynamics of Pacific herring (*Clupea palasii*), capelin (*Mallotus villosus*), and other coastal pelagic fishes in the eastern Bering Sea. Pp. 55-60 *In* Forage fishes of the southeastern Bering Sea. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990. U.S. Dept. Commerc., NOAA Tech. Memo. NMFS-AFSC-22. 150 pp.

SPECIES: EULACHON (Candlefish)

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	30-40 days	na	April-June	Rivers, FW	D	S (CB?)		4 - 8°C for egg development
Larvae	1-2 months ?	Copepods phytoplankton mysids, larvae	summer/fall	ICS ?	P?	U NA?	U	
Juveniles	2.5+ yrs up to age 3	Copepods Euphausiids	all year	MCS, OCS, USP	P	U NA?	U F?	
Adults	3 yrs ages 3-5+	 Copepods Euphausiids	spawning (May-June) non-spawning (July-Apr)	Rivers-FW MCS, OCS, USP	D P	S (CB?) NA?	 F?	

Habitat Description for Other Species Complex
Sculpins (*cottidae*)

Management Plan and Area(s): BSAI & GOA groundfish

Species Representatives:

Yellow Irish lord (*Hemilepidotus jordani)*
Red Irish lord (*Hemilepidotus hemilepidotus*)
Butterfly sculpin (*Hemilepidotus papilio*)
Bigmouth sculpin (*Hemitripterus bolini*)
Great sculpin (*Myoxocephalus polyacanthocephalus*)
Plain sculpin (*Myoxocephalus jaok*)

Life History and General Distribution

The Cottidae (sculpins) is a large circumboreal family of demersal fishes inhabiting a wide range of habitats in the north Pacific Ocean and Bering Sea. Most species live in shallow water or in tidepools, but some inhabit the deeper waters (to 1000 m) of the continental shelf and slope. Most species do not attain a large size (generally 10-15 cm), but those that live on the continental shelf and are caught by fisheries can be 30-50 cm; the cabezon is the largest sculpin and can be as long as 100 cm. Most sculpins spawn in the winter. All species lay eggs, but in some genera, fertilization is internal. The female commonly lays demersal eggs amongst rocks where they are guarded by males. Egg incubation duration is unknown; larvae were found across broad areas of the shelf and slope, and were found all year-round, in ichthyoplankton collections from the southeast Bering Sea and Gulf of Alaska. Larvae exhibit diel vertical migration (near surface at night and at depth during the day). Sculpins generally eat small invertebrates (e.g., crabs, barnacles, mussels), but fish are included in the diet of larger species; larvae eat copepods.

Yellow Irish lords: distributed from subtidal areas near shore to the edge of the continental shelf (down to 200 m) throughout the Bering Sea, Aleutian Islands, and eastward into the GOA as far as Sitka, AK; up to 40 cm in length. 12-26 mm larvae collected in spring on the western GOA shelf.

Red Irish lords: distributed from rocky, intertidal areas to about 100 m depth on the middle continental shelf (most shallower than 50 m), from California (Monterey Bay) to Kamchatka; throughout the Bering Sea and Gulf of Alaska; rarely over 30 cm in length. Spawns masses of pink eggs in shallow water or intertidally. Larvae were 7-20 mm long in spring in the western GOA.

Butterfly sculpins: distributed primarily in the western north Pacific and northern Bering Sea, from Hokkaido, Japan, Sea of Okhotsk, Chukchi Sea, to southeast Bering Sea and in Aleutian Islands; depths of 20-250 m, most frequent 50-100 m.

Bigmouth sculpin: distributed in deeper waters offshore, between about 100-300 m in the Bering Sea, Aleutian Islands, and throughout the Gulf of Alaska; up to 70 cm in length.

Great sculpin: distributed from the intertidal to 200 m, but may be most common on sand and muddy/sand bottoms in moderate depths (50-100 m); up to 80 cm in length. Found throughout the Bering Sea, Aleutian Islands, and Gulf of Alaska, but may be less common east of Prince William Sound. *Myoxocephalus* spp. larvae ranged in length from 9-16 mm in spring ichthyoplankton collections in the western GOA.

Plain sculpin: distributed throughout the Bering Sea and Gulf of Alaska (not common in the Aleutian Islands) from intertidal areas to depths of about 100 m, but most common in shallow waters (<50 m); up to 50 cm in length. *Myoxocephalus* spp. larvae ranged in length from 9-16 mm in spring ichthyoplankton collections in the western GOA.

Fishery:

Not a target of groundfish fisheries of BSAI or GOA, but sculpin bycatch (second to skates in weight amongst the Other Species) has ranged from 6,000-11,000 mt per year in the BSAI from 1992-95, and 500-1,400 mt per year in the GOA. Bycatch occurs principally in bottom trawl fisheries for flatfish, Pacific cod and pollock, but also while longlining for Pacific cod; almost all is discarded. Annual sculpin bycatch in the BSAI ranges between 1-4% of annual survey biomass estimates, however little is known of the species distribution of the bycatch.

Relevant Trophic Information

Feed on bottom invertebrates (e.g., crabs, barnacles, mussels and other molluscs); larger species eat fish.

What is the approximate upper size limit of juvenile fish (in cm)? Unknown

Sources for Additional Data:

Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961
Jim Blackburn, ADFG, Kodiak AK 907-486-1861

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Lay demersal eggs in nests guarded by males; many species in rocky shallow waters near shore.

Larvae: Distributed pelagically and in neuston across broad areas of shelf and slope, but predominantly on inner and middle shelf; have been found all year-round.

Juveniles and Adults: Sculpins are demersal fish, and live in a broad range of habitats from rocky intertidal pools to muddy bottoms of the continental shelf, and rocky, upper slope areas. Most commercial bycatch occurs on middle and outer shelf areas used by bottom trawlers for Pacific cod and flatfish.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and Northeastern Pacific. U.S. Dep. Commerc., NOAA Tech. Rept. NMFS 66, 151 p.

Doyle, M.J., W.C. Rugen, and R.D. Brodeur. 1995. Neustonic ichthyoplankton in the western Gulf of Alaska during spring. Fishery Bulletin 93: 231-253.

Eschmyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes, North America. Houghton Mifflin Co., Boston. 336 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

Kendall, A.W., Jr., and J.R. Dunn. 1985. Ichthyoplankton of the continental shelf near Kodiak Island, Alaska. U.S. Dep. Commerc., NOAA Tech. Rept NMFS 20, 89 p.

Kendall, A.W., Jr., J.R. Dunn, and R.J. Wolotira, Jr. 1980. Zooplankton, including ichthyoplankton and decapod larvae, of the Kodiak shelf. NWAFC Processed Rept. 80-8, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 393 p.

Rugen, W.C. 1990. Spatial and temporal distribution of larval fish in the western Gulf of Alaska, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*) larvae. NWAFC Processed Rept 90-01, AFSC-NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 162 p.

Waldron, K.D. 1978. Ichthyoplankton of the eastern Bering Sea, 11 February-16 March 1978. REFM Report, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 33 p.

Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the eastern Bering Sea. Final Report (RU 380), Environmental Assessment of the Alaskan continental shelf, REFM, AFSC, NMFS, 7600 Sand Point Way, NE, Seattle, WA 98115. 88 p.

SPECIES: SCULPINS

Stage - EFH Level	Duration or Age	Diet/Prey	Season-Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	na	winter?	BCH, ICS (MSC, OSC?)	D	R (others?)	U	
Larvae	U	copepods	all year?	ICS, MSC, OCS, US	N, P	na?	U	
Juveniles and Adults	U	bottom invertebrates (crabs, molluscs, barnacles) and small fish	all year	BCH, ICS, MSC, OSC, US	D	R, S, M, SM	U	

Habitat Description for Other Species Complex
Sharks

Management Plan and Area(s): BSAI & GOA groundfish

Species Representatives:

Lamnidae:	Salmon shark (*Lamna ditropis*)
Squalidae:	Sleeper shark (*Somniosus pacificus*)
	Spiny dogfish (*Squalus acanthias*)

Life History and General Distribution

Sharks of the order Squaliformes (which includes the two families Lamnidae and Squalidae) are the higher sharks with five gill slits and two dorsal fins. The Lamnidae are large, ovoviviparous (with small litters, 1-4; embryos nourished by intrauterine cannibalism), widely migrating sharks which are highly aggressive predators (salmon and white sharks). The Lamnidae are partly warm-blooded; the heavy trunk muscles are warmer than water for greater power and efficiency. Salmon sharks are distributed epipelagically along the shelf (can be found in shallow waters) from California through the Gulf of Alaska (where they occur all year and are probably most abundant in our area), the Bering Sea and off Japan. In groundfish fishery and survey data, occur chiefly on outer shelf/upper slope areas in the Bering Sea, but near coast to the outer shelf in the Gulf of Alaska, particularly near Kodiak Island. Not commonly seen in Aleutian Islands. They are believed to eat primarily fish, including salmon, sculpins and gadids, and can be up to 3 m in length.

The Pacific sleeper shark is distributed from California around the Pacific rim to Japan and in the Bering Sea principally on the outer shelf and upper slope (but has been observed nearshore), generally demersal (but also seen near surface). Other members of the Squalidae are ovoviviparous, but fertilization and development of sleeper sharks are not known; adults up to 8 m in length. Voracious, omnivorous predator of flatfish, cephalopods, rockfish, crabs, seals, salmon; may also prey on pinnipeds. In groundfish fishery and survey data, occur chiefly on outer shelf/upper slope areas in the Bering Sea, but near coast to the outer shelf in the Gulf of Alaska, particularly near Kodiak Island.

Spiny dogfish (or closely related species?) are widely distributed through the Atlantic, Pacific and Indian Oceans. In the north Pacific, may be most abundant in the Gulf of Alaska, but also common in the Bering Sea. Pelagic species, found at surface and to depths of 700 m; mostly 200 m or less on shelf and neritic; often found in aggregations. Ovoviviparous, with litter size proportional to size of female, from 2-9; gestation may be 22-24 months. Young are 24-30 cm at birth, with growth initially rapid, then slows dramatically. Maximum adult size is about 1.6 m, and 10 kg; maximum age about 40 years. 50% of females are mature at 94 cm and 29 years old; males, 72 cm and 19 years old. Females give birth in shallow coastal waters, usually in Sept-Jan. Dogfish eat a wide variety of foods, including fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus). Tagging experiments indicate local indigenous populations in some areas and widely migrating groups in others. May move inshore in summer and offshore in winter.

Fishery

Not a target of groundfish fisheries of BSAI or GOA, but shark bycatch has ranged from 300-700 mt per year in the BSAI from 1992-95; 500-1,400 mt per year in the GOA) principally by pelagic trawl fishery for pollock, longline fisheries for Pacific cod and sablefish, and bottom trawl fisheries for pollock, flatfish and cod; almost all discarded. Little is known of shark biomass in BSAI or GOA.

What is the approximate upper size limit of juvenile fish (in cm)?

Unknown for salmon sharks and sleeper sharks; for spiny dogfish: 94 cm for females, 72 cm for males.

Source of Additional Data

William Raschi, Bucknell University,

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Salmon sharks and spiny dogfish are ovoviviparous; reproductive strategy of sleeper sharks is not known. Spiny dogfish give birth in shallow coastal waters, while salmon sharks probably offshore and pelagic.

Juveniles and Adults: Spiny dogfish are widely dispersed throughout the water column on shelf in the GOA, and along outer shelf in the BS; apparently not as commonly found in the Aleutian Islands and not commonly at depths > 200 m.

Salmon sharks found throughout the GOA, but less common in the BS and AI; epipelagic, primarily over shelf/slope waters in GOA, and outer shelf in BS.

Sleeper sharks are widely dispersed on shelf/upper slope in the GOA, and along outer shelf/upper slope only in the BS; generally demersal, and may be less commonly found in the Aleutian Islands.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and Northeastern Pacific. U.S. Dep. Commerc., NOAA Tech. Rept. NMFS 66, 151 p.

Eschmyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes, North America. Houghton Mifflin Co., Boston. 336 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

SPECIES: SHARKS

Stage - EFH Level	Duration or Age	Diet/Prey	Season-Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs								
Larvae								
Juveniles and Adults								
Salmon shark	U	fish (salmon, sculpins and gadids)	all year	ICS, MSC, OCS, US in GOA; OCS, US in BSAI	P	NA	U	
Sleeper shark	U	omnivorous; flatfish, cephalopods, rockfish, crabs, seals, salmon, pinnipeds	all year	ICS, MSC, OCS, US in GOA; OCS, US in BSAI	D	U	U	
Spiny dogfish	40 years	fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus)	all year	ICS, MSC, OCS in GOA; OCS in BSAI give birth ICS in fall/winter?	P	U	U	Euhaline 4-16°C

Habitat Description for Other Species Complex
Skates (*Rajidae*)

Management Plan and Area(s): BSAI & GOA groundfish

Species Representatives:

Alaska skate (*Bathyraja parmifera*)
Aleutian skate (*Bathyraja aleutica*)
Bering skate (*Bathyraja interrupta*)

Life History and General Distribution:

Skates (Rajidae) that occur in the BSAI and GOA are grouped into two genera: *Bathyraja* sp., or soft-nosed species (rostral cartilage slender and snout soft and flexible), and *Raja* sp., or hard-nosed species (rostral cartilage is thick making the snout rigid). Skates are oviparous; fertilization is internal and eggs (one to five or more in each case) are deposited in horny cases for incubation. Adults and juveniles are demersal, and feed on bottom invertebrates and fish. Adult distributions from survey: Alaska skate: mostly 50-200 m on shelf in eastern Bering Sea (EBS) and Aleutian Islands (AI), less common in the Gulf of Alaska (GOA); Aleutian skate: throughout EBS and AI, but less common in GOA, mostly 100-350 m; Bering Skate: throughout EBS and GOA, less common in AI, mostly 100-350 m. Little is known of their habitat requirements for growth or reproduction, nor of any seasonal movements. BSAI skate biomass estimate more than doubled between 1982-96 from bottom trawl survey; may have decreased in GOA and remained stable in the AI in the 1980s.

Fishery

Not a target of groundfish fisheries of BSAI or GOA, but caught as bycatch (13,000-17,000 mt per year in the BSAI from 1992-95; 1,000-2,000 mt per year in the GOA) principally by the longline Pacific cod and bottom trawl pollock and flatfish fisheries; almost all discarded. Skate bycatches in the EBS groundfisheries ranged between 1-4% of the annual EBS trawl survey biomass estimates in 1992-95.

Relevant Trophic Information

Feed on bottom invertebrates (crustaceans, molluscs, and polychaetes) and fish.

What is the approximate upper size limit of juvenile fish (in cm)? Unknown

Source of Additional Data

William Raschi, Bucknell University

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Deposit eggs in horny cases on shelf and slope.

Juveniles and Adults: After hatching, juveniles probably remain in shelf and slope waters, but distribution is unknown. Adults found across wide areas of shelf and slope; surveys found most skates at depths <500 m in the GOA and EBS, but >500 m in the AI. In the GOA, most skates found between 4-7°C, but data are limited.

Literature

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and Northeastern Pacific. U.S. Dep. Commerc., NOAA Tech. Rept. NMFS 66, 151 p.

Eschmyer, W.N., and E.S. Herald. 1983. A field guide to Pacific coast fishes, North America. Houghton Mifflin Co., Boston. 336 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Hart, J.L. 1973. Pacific fishes of Canada. Fisheries Res. Bd. Canada Bull. 180. Ottawa. 740 p.

Teshima, K., and T.K. Wilderbuer. 1990. Distribution and abundance of skates in the eastern Bering Sea, Aleutian Islands region, and the Gulf of Alaska. Pp. 257-267 *in* H.L. Pratt, Jr., S.H. Gruber, and T. Taniuchi (eds.), Elasmobranchs as living resources: advances in the biology, ecology, systematics and the status of the fisheries. U.S. Dep. Commerc., NOAA Technical Report 90.

SPECIES: SKATES

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	U	na	U	MCS, OCS, USP	D	U	U	
Larvae	na	na	na	na	na	na	na	
Juveniles	U	Invertebrates small fish	all year	MCS, OCS, USP	D	U	U	
Adults	U	Invertebrates small fish	all year	MCS, OCS, USP	D	U	U	

Habitat Description for Other Species Complex
Octopus (*Cephalopoda*)

Management Plan and Area(s): BSAI & GOA groundfish

Species Representatives:

Octopoda: Octopus *(Octopus gilbertianus; O. dofleini*)
Vampyromorpha: Pelagic octopus (*Vampyroteuthis infernalis*)

Life History and General Distribution

Octopus are members of the molluscan class Cephalopoda, along with squid, cuttlefish and nautiloids. In the BSAI and GOA, the most commonly encountered octopods are the shelf demersal species *O. gilbertianus* and *O. dofleini*, and the bathypelagic finned species, *V. infernalis*. Octopods, like other cephalopods are dioecious, with fertilization of eggs (usually within the mantle cavity of the female) requiring transfer of spermatophores during copulation. Octopods probably do not live longer than about 2-4 years, and females of some species (e.g., *O. vulgaris*) die after brooding their eggs on the bottom.

O. gilbertianus - Medium sized octopus (up to 2 m in total length) distributed across the shelf (to 500 m depth) in the eastern and western Bering Sea (where it is the most common octopus), Aleutian Islands, and Gulf of Alaska (endemic to the North Pacific). Little is known of its reproductive or trophic ecology, but eggs laid on the bottom and tended by females. Lives mainly among rocks and stones.

O. dofleini - Giant octopus (up to 10 m in total length, though mostly about 3-5 m) distributed in the southern boreal region from Japan and Korea, through the Aleutian Islands, Gulf Alaska, and south along the Pacific coast of North America to California. Inhabits the sublittoral to upper slope. Egg length 6-8 mm; laid on bottom. Copulation may occur in late fall-winter, but oviposition the following spring; each female lays several hundred eggs.

V. infernalis - Relatively small (up to about 40 cm total length) bathypelagic species, living at depths well below the thermocline; may be most commonly found at 700-1500 m. Found throughout the world's oceans. Eggs are large (3-4 mm in diameter) and are shed singly into the water. Hatched juveniles resemble adults, but with different fin arrangements, which change to the adult form with development. Little is known of their food habits, longevity, or abundance.

Fishery:

Not currently a target of groundfish fisheries of BSAI or GOA. Bycatch has ranged between 200-1,000 mt in the BSAI and 40-100 mt in the GOA, chiefly in the pot fishery for Pacific cod and bottom trawl fisheries for cod and flatfish, but sometimes in the pelagic trawl pollock fishery. Directed octopus landings have been less than 8 mt/year for 1988-95. Age/size at 50% recruitment is unknown. Most of the bycatch occurs on the outer continental shelf (100-200 m depth), chiefly north of the Alaskan peninsula from Unimak I. To Port Moller and northwest to the Pribilof Islands; also around Kodiak Island and many of the Aleutian Islands.

Relevant Trophic Information

Octopus are eaten by pinnipeds (principally Steller sea lions, and spotted, bearded, and harbor seals) and a variety of fishes, including Pacific halibut and Pacific cod (Yang 1993). When small, octopods eat planktonic

and small benthic crustaceans (mysids, amphipods, copepods). As adults, octopus eat benthic crustaceans (crabs) and molluscs (clams).

What is the approximate upper size limit of juvenile fish (in cm)? Unknown

Additional source of information Unknown

Habitat Narrative for *Octopus* spp.:

Egg/Spawning: shelf; eggs laid on bottom, maybe preferentially among rocks and cobble.

Young Juveniles: semi-demersal; widely dispersed on shelf, upper slope

Old Juveniles and Adults: demersal, widely dispersed on shelf and upper slope, preferentially among rocks, cobble, but also on sand/mud.

Literature

Akimushkin, I.I. 1963. Cephalopods of the seas of the U.S.S.R. Academy of Sciences of the U.S.S.R., Institute of Oceanology, Moscow. Translated from Russian by Israel Program for Scientific Translations, Jerusalem 1965. 223 p.

Fritz, L.W. 1996. Other species *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as Projected for 1997. North Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.

Nesis, K.N. 1987. Cephalopods of the world. TFH Publications, Neptune City, NJ, USA. 351 pp.

Perez, M. 1990. Review of marine mammal population and prey information for Bering Sea ecosystem studies. U.S. Dep. Commerc., NOAA Tech. Memo. NMFS F/NWC-186, 81 p.

Yang, M.S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990. U.S. Dep. Commerc., NOAA Tech. Memo. NMFS-AFSC-22, 150 p.

SPECIES: *Octopus dofleini, O. gilbertianus*

Stage - EFH Level	**Duration or Age**	**Diet/Prey**	**Season-Time**	**Location**	**Water Column**	**Bottom Type**	**Oceano-graphic Features**	**Other**
Eggs	U (1-2 months?)	NA	spring-summer?	U (IS, MS?)	D	R, G?	U	Euhaline waters
Young juveniles	U	zooplankton	summer-fall?	U (IS, MS, OS, USL?)	D, SD	U	U	Euhaline waters
Older Juveniles and Adults	U (2-3 yrs? for *O.gilbertianus*; older for *O.dofleini*)	crustaceans, molluscs	all year	IS, MS, OS, USL	D	R, G, S, MS?	U	Euhaline waters

RESEARCH NEEDS

The EFH Core Team developed a draft framework for evaluating research and management activities. The framework reflects the Team's strategy of organizing efforts and activities around the goals of protecting and managing habitat essential to productive fisheries. By evaluating current knowledge levels and status of EFH, priority research and management activities can be identified for the various FMPs. In applying the framework to groundfish, priorities are narrowed to where level 0 information for EFH intersects with habitats that are most at risk to human activities. The Team considered this intersection to be bottom habitats where groundfish fisheries take place as well as nearshore areas subject to shoreside and upland development. Specific research needs are:

- Information on habitat distribution, in conjunction with fish distribution is necessary to determine species habitat requirements and utilization. Information on the extent and distribution of complex habitat types easily impacted by bottomfishing will greatly improve the ability to evaluate the potential of a fishery to physically alter bottom habitat and evaluate proposed measures to minimize impacts on EFH. To attain this information we recommend increased support to evaluate remote bottom typing technology and increased application of currently available technology such as multi-beam sonar, that can provide detailed topographic maps of the continental shelf and slope.

- Surveys and studies of nearshore pelagic and benthic areas are needed to determine their use by a variety of species, including Atka mackerel, Pacific cod, pelagic rockfishes, sablefish, octopus, flatfishes, salmon, and juveniles and larvae of all species and forage species considered in NPFMC FMPs.